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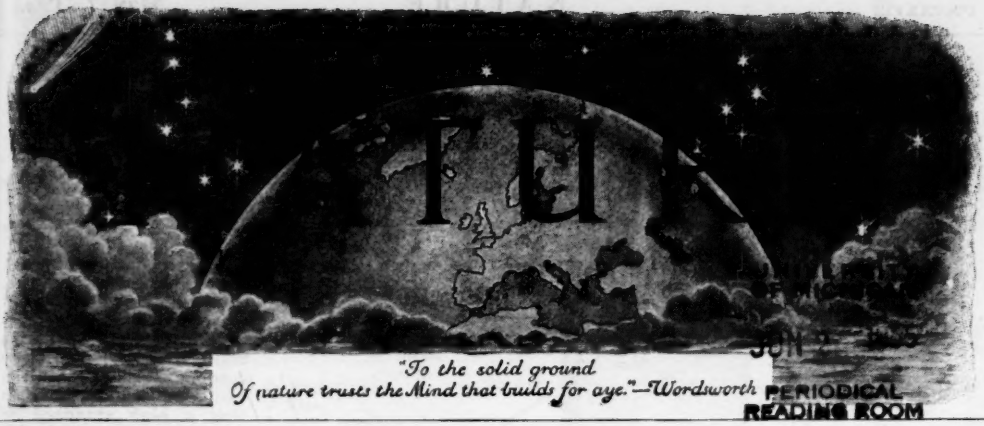

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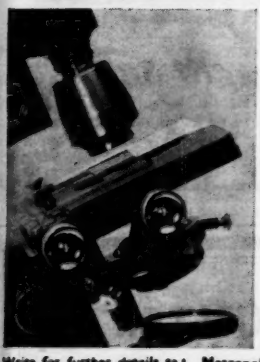

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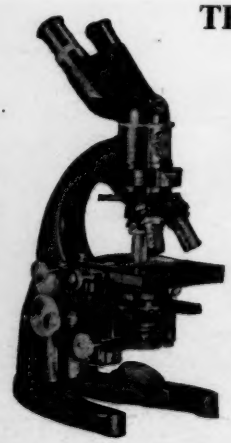

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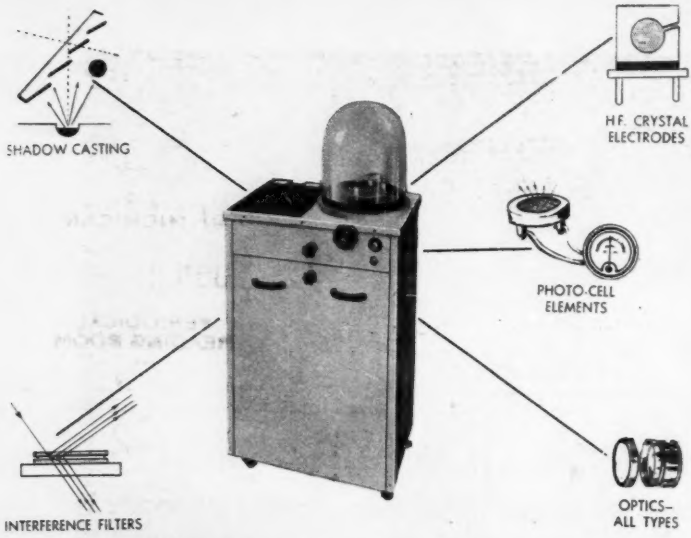

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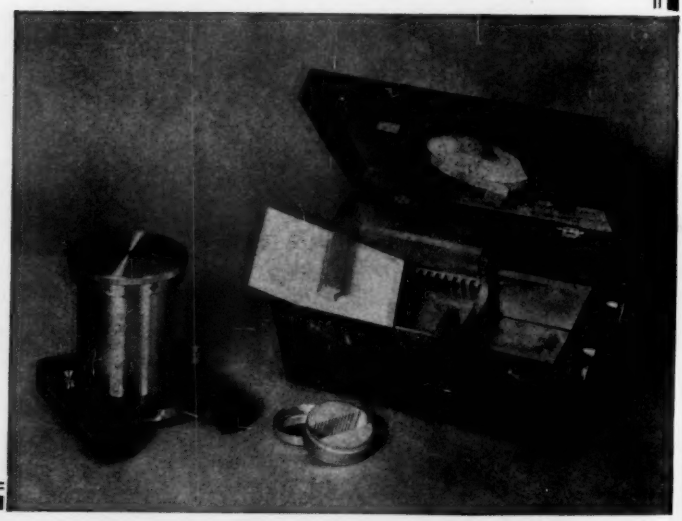

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NATURE

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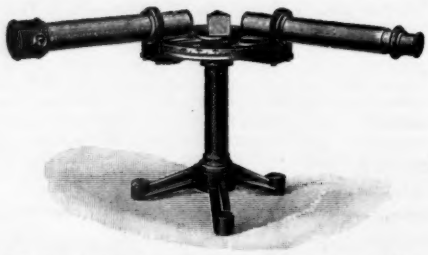

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ADULT EDUCATION

In June 1953, the Minister of Education appointed a Committee to review the present system by which the extra-mural departments of universities, the Workers' Educational Association and the other responsible bodies provide local facilities for adult education. The Committee reported in August 1954 (*Nature*, **174**, 865; 1954) and, after a long and searching analysis of the adult education movement of Great Britain, made recommendations to remove many of the frustrations which beset the voluntary organizations, university extra-mural departments, and full-time and part-time tutors, and which have led to much introspective discussion since the end of the War. The recommendations of the Committee have recently been considered by the Minister of Education who, on April 8, announced in the House of Commons that he was able to agree with almost all its recommendations.

Among the recommendations of the Committee were that the Ministry's policy on adult education should always be such as to encourage voluntaryism and that the Workers' Educational Association districts should be encouraged to preserve their status as responsible bodies and continue both to organize and to provide classes. Those in touch with adult education know that many of the difficulties with which the movement has had to grapple have arisen out of conflict, often politely concealed but none the less real, between organizations like the Workers' Educational Association and a number of university extra-mural departments.

The chairman of the Ministry of Education Committee was Dr. Eric Ashby, and in the William F. Harvey Memorial Lecture* at Fircroft College on March 24 he has personally carried the analysis of current adult education difficulties much farther than would be possible in an official report prepared by a committee.

Never has there been a more penetrating or more candid analysis of what Ashby sorrowfully calls the pathology of adult education; never has the case for voluntaryism been more ably presented. With all the evidence before him, Ashby steps down from his official position and takes on the role of physician to a movement for which he has patently so great a regard.

After a historical review of the growth of the adult education movement in Britain and a commentary on its successive booms and slumps, Ashby carries out a meticulous diagnosis of the ills now so manifest in some sectors of the movement.

The decline in popularity of the Workers' Educational Association is due to the re-awakening of university extension. Formerly, the universities were content to do much of their extra-mural work through voluntary bodies. As some W.E.A. branches declined, enterprising university tutors moved in and, in a number of cases, set up *ad hoc* committees to organize classes direct. If universities and the Workers' Educational Association had been equal partners, this kind of incident would have resulted in nothing more than healthy competition. Unfortunately, university extra-mural departments have access to funds which are not available to the W.E.A. In time a few university extra-mural departments found that it was simpler to arrange classes by dispensing altogether with the services of W.E.A. branches.

Although this kind of incident has happened only in a few areas in Great Britain, its implications have spread far beyond those regions and have injured the health of extra-mural work in the Workers' Educational Association and in the universities. One of the more unfortunate consequences of the internecine warfare between some branches of the W.E.A. and university extra-mural departments is that many friends of adult education who wish to contribute to its development have rightly refused to give allegiance to either side. They stand sadly aside with thoughts murmuring "a plague on both your houses".

In the W.E.A., the injury has resulted in a tendency for persistent and recurrent self-examination which is beginning to verge on hypochondria. At the end of the outbursts, the W.E.A. has had little to produce except the icons of the Association and what they stood for many years ago. Where liberal education classes for 'workers' have been difficult to organize, the line of least resistance has been taken and more 'popular' classes arranged.

Both extra-mural departments and Workers' Educational Association branches are defeatist about collecting reasonable fees from students. In many cases these are now no higher than they were forty years ago; at least one extra-mural director believes that classes should be completely free. This is not the view of Sir David Eccles who, in his statement in the House of Commons, said that he expected some further contribution towards the increased cost of adult education, either in the form of higher fees from students or in other ways.

These outward and visible signs of disorder are not chronic or incurable, but, in Ashby's words, "it is of the utmost importance that voluntary bodies engaged in adult education should rid themselves of these disorders in order that the spirit of voluntaryism in British adult education may be preserved".

The symptoms of ill-health in university extra-mural departments take a different form; they are the symptoms of intellectual pride. "University extra-mural departments have already arrogated to themselves moral responsibility for liberal adult education in Britain. If you can persuade extra-mural directors to be frank, some of them will tell you that the W.E.A. is no longer necessary to interpret the university to the people; indeed that the Association is a survival of an obsolete class distinction and it actually puts some students off; that the universities are the architects of post-war adult education and they are carrying the voluntary bodies on their backs. You will hear that the first mission

* William F. Harvey Memorial Lecture, published by the Printer to the University, The Queen's University, Belfast, pp. 24 (1955).

of adult education was to be remedial, to reach the educationally under-privileged. You will be told that times have changed; that remedial education will become superfluous as the Welfare State develops; and that the universities should apply themselves to a new public: those who already have secondary or even tertiary education."

Although there is some truth in these assertions, there is not enough to justify a retreat from the principle that universities should conduct a large part of their extra-mural work through voluntary bodies. The symptoms themselves may spring from a new ailment in adult education, the pathology of a movement which enjoys too much security. Moreover, if university extra-mural departments are to be concerned with the products of higher education only, "who is to be responsible for adult education among the eight out of ten children who never enter a grammar school at all and among the nearly half a million children who at present leave school before their sixteenth birthdays?"

The resurgence of university extension work is accompanied by three dangers. First, adult education may become more and more professionalized. The original Workers' Educational Association tutorial classes were of university standard and taken by distinguished teachers like R. H. Tawney, A. L. Smith and A. D. Lindsay. Their place has been taken by a professional service of tutors: they are no longer men who teach in the university.

Frequently the tutors have little opportunity of mixing with their colleagues and "it is stretching a point to say that they 'come from the university' at all". While he may be a competent teacher, the professional tutor is likely to be a little less sympathetic with the voluntary groups on whose clumsy and sometimes ill-advised counsels his profession depends; and a little less critical of the genuineness of demands for classes when he has whipped up the demands himself. Too often these classes decline rapidly because they fail to satisfy real need. The Minister's announcement that higher salaries are to be paid to tutors of certain grades may enable university extra-mural departments to recruit from an enlarged field to include men who have had experience in ways of life other than teaching.

In days when many students are vitally interested in topics related to their work as supervisors or trade unionists in industry and commerce, too many classes are taken by tutors who have had little genuine contact with industry; they are about as effective as doctors would be if their studies had embraced anatomy and physiology but they had failed to 'walk the wards'. Many existing tutors served their movement well in days when most classes were concerned with economics, history and philosophy. With the challenge to provide classes in various aspects of industrial relations and organization, extra-mural departments and the voluntary organizations might well consider whether their movement might not be better served by the greater use of more part-time tutors drawn from industry—men whose teaching would be constantly illuminated by examples drawn from their daily practical experience.

Secondly, the resurgence of university extension work to the detriment of work by voluntary bodies may in the long run identify adult education too closely with academic education. Extra-mural tutors need to compensate for the decay of craftsmanship in industry, to equip adults to use some of their leisure to keep alive standards of excellence in crafts, in music played at home, and in the amateur practice of the fine arts. There is also the danger that extra-mural tutors seek to pass on to their students the compartmental specializations which they themselves have absorbed under a university system codified for examination purposes. Universities too often forget that examinable knowledge is not the only knowledge. This may explain the paucity of science-teaching in adult education. Science, with all its fascination, is often neglected in adult education because tutors can teach it only as they learnt it, and "this requires laboratories, equipment, a jargon of terms, a familiarity with technique". Science in adult education could be taught quite differently. What the citizen should know about chemistry and biology can be acquired without ever going into a laboratory: but only through new methods of teaching which the universities are not likely to evolve themselves.

Thirdly, there is the danger that adult education may become a social service like national insurance, 'laid on' by the university in a spirit of efficient paternalism. Educational shock troops descend on a district and create a demand by means of bright pioneer classes. These are followed by tutors offering more sustained and more advanced classes. Too often these classes decline rapidly because they fail to meet real need. The danger is that the voluntary spirit may disappear from adult education.

Ashby's inquiry does not end with pathology. If the techniques of adult education are to retain liveliness, they must be directed to the solving of immediate problems. When these problems are solved the techniques are likely to become out-moded, and adult education can maintain its virility only by turning to fresh problems and devising fresh techniques to solve them. The driving force behind the tutorial class movement was to win social emancipation and to fit the worker to take political responsibility. Social emancipation and political responsibility have now been acquired. New problems have emerged. The chief problem, as Ashby trenchantly says, "is that we live in a society which confers on the worker (irrespective of whether he is manual or clerical and irrespective of the amount of education he has) political responsibility, civic rights and leisure. The contemporary problem in adult education is that among many people at all levels of education the leisure is without purpose, the civic rights are without significance, and the political responsibility is assumed without understanding; social emancipation without personal emancipation is of little value. To preserve man's status as an individual is the contemporary task for adult education; techniques are needed for achieving personal emancipation among students".

The first prerequisite for the healthy survival of adult education in Britain is the presence of thousands of small voluntary groups. The second is that the

voluntary group should have its own roof over its head. In addition, a more realistic policy is needed on the part of those who organize adult education. There is evidence that serious education will never appeal to more than a very small minority. Insipid forms of educational amusement are much more efficiently provided by the techniques of mass education (the film society, the B.B.C. Third Programme and television) than by the techniques of the tutorial class. Surely it is desirable to confine university participation in adult education to the supervision of small groups prepared to devote themselves to one topic for at least one year: discussing, arguing, writing about the fundamental unresolved problems of men and Nature; or seeking personal emancipation in a genuine scholarly understanding of some aspect of literature or the arts; or finding a deep satisfaction in doing some craftsman's work really well.

THE BRITISH MUSEUM *ARCHAEOPTERYX*

Archaeopteryx Lithographica

A Study based upon the British Museum Specimen. By Sir Gavin de Beer. Pp. xi+68+16 plates. (London: British Museum (Natural History), 1954.) 40*s*.

THE specimen of *Archaeopteryx*, 'the first bird', is certainly the best known fossil in the British Museum (Natural History), and it is proper that it should be examined as completely as is now possible, and lavishly published. Thus Sir Gavin de Beer's monograph is very welcome. In it he gives a detailed account of its discovery and purchase from Dr. Häberlein, the family doctor of Pappenheim, who received it in payment for medical services to the quarrymen. He gives also the facts, pungently published by John Ruskin in 1864, of the payment of the price—£700—in two instalments, the second guaranteed by Richard Owen, since the Museum Trustees were not in a position to do so. The sum paid formed the dowry of Häberlein's daughter.

The specimen so acquired was immediately described by Owen (1863). Then John Evans (later Lord Lubbock) discovered on the slab a jaw bone with teeth, and a brain cast, and it at once appeared in all general works dealing with geology and evolution. Later it has been the subject of very many papers. But only when a Serbian philosopher, B. Petronievics, examined it during the First World War was it actually prepared by Mr. F. O. Barlow, who exposed the shoulder girdle and pelvis, described by Petronievics in association with A. Smith Woodward. Petronievics returned to the work, and further preparation by Barlow and L. E. Parsons exposed much of the vertebral column and other elements of the girdles.

The next important contribution to our knowledge of its structure was the recognition by Dr. Tilly Edinger that Evans's brain cast was actually such, and that the brain it represented was of the type found in modern reptiles, and lacked the qualities characteristic of modern birds. Meanwhile, a second skeleton in Berlin was described by Dames and, as it has a good skull, was widely discussed. At first regarded as belonging to the same species as the London specimen, it later came to be considered as a member of a different species, then genus, and finally family!

During recent years Mr. Parsons has carried out further preparation; the slab has been examined by X-rays, and examined under ultra-violet light by K. Lambrecht in 1928. Sir Gavin de Beer, photographing the specimen by its own fluorescence under ultra-violet light, has made out new structures, especially the long-sought sternum. He confirms Dr. Edlinger's account of the brain cast and finds a continuous series of twenty vertebræ in front of the tail, and two displaced cervicals. He finds, too, many abdominal ribs, as in the Berlin specimen. But the most important discovery is of a sternum, a thin sheet of very spongy bone, transversely widened, very short along the bird's length, and appropriate to the short flattened coracoids, which presumably articulate with it. Little can be added to what is at present known about the limb skeleton; but Sir Gavin agrees with Lambrecht in holding that the skeleton was not pneumatic. The feathers of the wings have always been recognized as singularly resembling those of modern birds, and Steiner endeavoured to show that *Archaeopteryx* lacked a fifth secondary and was 'aquinto-cubital'. Sir Gavin shows that the feather impressions were made by the under-surface, and that sometimes a single feather made two impressions. His detailed discussion, based not only on direct visual observation but also on large photographs made with glancing illumination in four azimuths, is convincing. It shows that Steiner was wrong, and that the flight feathers are identical with those of modern flying-birds.

Sir Gavin compares the two specimens of *Archaeopteryx* and concludes, without certainty, that they may well belong to the same species. He then goes on to consider the affinities of the bird, holding that a derivation from some reptile of the general nature of *Euparkeria* is reasonable, in agreement with Robert Broom. Then he goes on to discuss the origin of flight, rejecting the 'pro-avis' theory of Steiner, the cursorial pro-avis of Nopsca, Beebe's tetrapteryx theory, and returning to the classical arboreal origin.

The whole work is most useful, it establishes definitely many previously doubtful structural features, and discusses many problems on a reliable basis of fact, and with a well-controlled imagination. The work is illustrated by fifteen large photographic plates, some taken by ordinary, often glancing light, others by phosphorescence under ultra-violet illumination. They establish the facts well enough; but it still seems to be difficult to take such good photographs, and to have such good blocks made from them, as the French museums regularly do.

D. M. S. WATSON

GENESIS OF MODERN SCIENCE

The Scientific Revolution 1500–1800

The Formation of the Modern Scientific Attitude. By Dr. A. R. Hall. Pp. xvii+390. (London: Longmans, Green and Co., Ltd., 1954.) 21*s*. net.

THE inauguration in Great Britain of the systematic study of the history and philosophy of science has promoted the publication of a number of works which have implicitly, or in some cases explicitly, aimed at particular readjustments in historical and sociological perspective. Few historians

would now be so bold, or so purblind, as to ignore the existence of scientific activity before the Ionian Greeks; to write off the millennium of the Middle Ages as one of unparalleled gloom and sterility; or to ignore the economic motives or implications of discovery. But the time was ripe for a candid reassessment of the whole problem of the genesis of science as we know it to-day. This task has, in my opinion, been admirably achieved by Dr. A. R. Hall in this book.

After sketching the state of scientific knowledge at about the year 1500, as it was portrayed in the widely esteemed "Margarita Philosophica", Dr. Hall considers the tentative groupings, marked by many false starts, which characterized the sixteenth century. Here what was radical innovation in such outstanding men as Vesalius and Tycho Brahe is clearly distinguished from the indications of mental inertia which characterized even the most active minds. Then follows a discussion of the attack on tradition in astronomy, mechanics and biology. Galileo's part in this is presented as truthfully as is possible within the space available, and, what is less often done, Descartes's relative failure is shown to have been due, as Prof. N. Kemp Smith has recently emphasized, to his lack of interest in applied mathematics. The comparison is taken up again in the chapter on the principles of science in the early seventeenth century, where the invaluable role of Descartes as 'publicist' of the new mechanical approach to the deductive grounding of natural philosophy (in the widest sense of that term) is well brought out. The technical aspects are dealt with in a separate chapter, where the relation between specialized craft and theoretical advance is neatly expressed in the words: "Common craftsmen held a considerable reservoir of ingenuity, when scientific imagination arrived to draw upon it". A very good account is given of the Principate of Newton in which that great man's achievement is clearly related to that of his contemporaries. But although the author mentions that Newton "gave to science formal concepts of space and time", he does not indicate the light which Newton's naïve (though within its context highly effective) enunciation of these concepts casts on the whole question of the nature of scientific thought.

In the far-ranging and stimulating account of descriptive biology and systematics there is a slip in terminology: Cesalpino could scarcely have made much progress by taking the seed as a basis of classification; it was, of course, the fruit. Incidentally, it is necessary to point out that Linnæus's use of the number of 'styles' as the *differentia* within the classes must be interpreted as the number of free female organs, otherwise the class Hexandria Monogynia (p. 294) could scarcely be described as having "styles 0". The chapter on the origins of chemistry includes an estimate of Boyle as "essentially a physicist looking at chemistry", which though cogently argued is unlikely to gain general assent. Neither is it quite fair to Mayow to say that Hales "invented" the technique of collecting gases over water, nor to Scheele to call him a "German apothecary", even though it is true that Stralsund was later incorporated into German territory. The book concludes with a review of physics in the eighteenth century. Valuable appendixes on botanical illustration and rival planetary theories are added, together with excellent bibliographical aids and a not quite so excellent index—here a little expansion would have been helpful.

In the recently published "Dialogues" nothing is more striking than Whitehead's insistence on the complete dissolution of the conceptual framework of physics during his lifetime. This suggests the only major criticism of Dr. Hall's book—or rather of his title—namely, that for one reader at least it has provided yet another admirable document in support of the view that no single revolution has ever taken place. Not only (as the title indicates) is the time-lapse too great, but also, to the extent that crises were recognizable, they took place at widely different times in different departments of science. We are now in the middle of the third in the fundamental science of physics. Dr. Hall makes no claim that he has said the last word on the subject. What a reviewer may claim is that in providing an admirably constructed and most attractively presented schema on which subsequent research may be based, he has done something far more valuable. Printer and publisher are also to be congratulated on a production of such quality, and at a price which should enable everyone interested in science and civilization to read and re-read it.

William P. D. Wightman

MODERN PHYSICAL METALLURGY

Progress in Metal Physics

Edited by Dr. Bruce Chalmers and R. King. (Progress Series.) Vol. 5. Pp. vii + 324 + 36 plates. (London: Pergamon Press, Ltd., 1954.) 60*s*. net.

By far the longest of the five reviews comprising this fifth volume in the series is the report on precipitation, by H. K. Hardy and T. J. Heal. This is not surprising, for more than a thousand papers relating to precipitation have been published, and reference is here made to no less than three hundred and fifty of them. The report affords an excellent illustration of the advantages which accrue when the authors of critical reviews are themselves active in the field under discussion. The treatment is comprehensive and systematic, from both theoretical and experimental points of view. It shows, on one hand, how much has been achieved and yet, on the other, how little is really known about this subject. A critical assessment of knowledge on the precipitation process for a number of alloy systems leads to the conclusion that only for the aluminium–copper system can a qualitative account of the ageing process at all degrees of super-saturation be given with some degree of certainty.

From time to time urgent technological problems profoundly influence the direction taken by fundamental research by focusing attention upon basic phenomena about which little is known. In this way the catastrophic brittle failure of mild-steel ships' plates has led to a greatly increased interest in the general problem of fracture, and research to minimize such failures by control of metallurgical factors has been accompanied by widespread effort to elucidate the mechanism of fracture in general. Both aspects are adequately dealt with in an interesting and readable review by N. J. Petch on the fracture of metals.

Experimental observations of slip and twinning in metal crystals are of vital importance to the proper understanding of plastic deformation. Generalizations may be made about the simpler features, but as greater detail is revealed the picture becomes one of increasing complexity. This is clearly illustrated by

the review on geometrical aspects of the plastic deformation of metal single crystals, in which R. Maddin and N. K. Chen have summarized the experimental evidence according to the crystal structure of the metal concerned.

The review on the structure of liquid metals, by B. R. T. Frost, is particularly timely because of the interest now being shown in the subject. Both indirect and direct methods of obtaining information about the arrangement of atoms in liquid metals are reviewed in an interesting and comprehensive manner. By contrast, the solidification of metals, by Ursula M. Martius, is more restricted in its scope. It is mainly concerned with the work of the Toronto school and is limited to the solidification of a single phase and in particular to what happens after the crystal nucleus has been formed. A less general title would have been more appropriate for this review.

By and large, however, this is a useful volume that will bear comparison with the best of the earlier ones in the series. It will be used by many metallurgists who would not regard themselves as metal physicists, and it is therefore unfortunate that in their preface the editors stress the idea that there is now a ". . . distinct study of Metal Physics". In any technology satisfactory development and progress depend upon the continuous assimilation of new knowledge. Metallurgy as we know it to-day exists because knowledge and ideas which at one time seemed far ahead of and remote from practical considerations have been assimilated into 'classical' metallurgy. This process must go on, and nothing should be done that may prevent or delay new discoveries and conceptions in the science of metals from being absorbed into the technology of metallurgy.

A. G. QUARRELL

A GEOCHEMICAL CLASSIC

Geochemistry

By the late Prof. V. M. Goldschmidt. (International Series of Monographs on Physics.) Pp. xi+730. (Oxford: Clarendon Press; London: Oxford University Press, 1954.) 63*s*. net.

CLARKE'S celebrated "Data of Geochemistry"—still the leading best-seller of the United States Geological Survey—represents the culmination of the first long pioneering stage of geochemistry, a period that was characterized by the accumulation of the outstanding facts on a macro scale. Similarly, this great work by V. M. Goldschmidt is already the unrivalled classic of the second stage of the subject, which was characterized by the discovery of the relations between ionic radii and the distribution and associations of elements, and by the successful application of X-ray and optical spectrography to the many problems associated with 'trace elements'. In these and related fields Goldschmidt was the acknowledged leader. His book is brightly illumined by the high-lights of his own achievements and inspirations, and may be confidently hailed as one of those rare contributions to scientific literature which long remain a delight to read and a potent stimulant to further research. This assessment is unaffected by the fact that geochemistry has already passed its second climax and has entered the third stage of its development, with isotopic investigations now well established in the van of progress. For this reason the book is unavoidably out of date in some respects, certain chapters having been left unfinished at the time of Goldschmidt's lamented death in 1947. But access to recent work presents no difficulties, whereas for access to the mature thoughts of geochemistry's greatest genius there is no alternative to this inimitable book, in which, moreover, the hitherto unpublished results of Goldschmidt's latest work have been incorporated.

The work of editing and filling in the gaps has been skilfully carried out by Dr. Alex Muir, with the assistance of a number of devoted friends, whose translations and other contributions are fully acknowledged in a preliminary note. At his discretion, and always within square brackets, the editor has here and there added comments on recent advances and references thereto. Most of the gaps were in the first of the two parts into which the book is divided. Part 1 consists of six chapters (one hundred and twenty-five pages) dealing with the scope and development of the subject; the distribution of elements during the evolution of the earth and the crystallization of magmas; the fundamental data required in the quantitative treatment of geochemical processes, in the cosmos as well as in the earth and its various 'spheres'; and finally with the principles of crystal chemistry, this being the part of the subject with which Goldschmidt's name is most intimately associated.

Part 2 deals in fifty-seven sections (nearly six hundred pages) with the abundances, crystal chemistry and distribution of the elements in minerals, ores, rocks, soils, organisms, waters and atmosphere; with their natural circulations; and with relevant data for meteorites and various parts of the cosmos. This bald statement, however, fails to give any idea of the liveliness and exciting quality of these fascinating pages, or of the variety of topics that come under discussion. Under beryllium we learn the reasons for the colour and rarity of emerald. Granitization is discussed under sodium. Silicon introduces the origin of flint and its curious properties, the recognition of which by the craftsmen of the Stone Age laid "the material foundations of modern civilisation". Nitrogen raises the intractable geochemical problems of the Chilean nitrate deposits; Goldschmidt meets the challenge by proposing promising new lines of investigation. It is well known that in 1922 Goldschmidt inferred from geochemical principles the existence of a sulphide–oxide layer between the core and the silicate mantle of the earth. Although current geophysical evidence fails to support this view, as Goldschmidt fully realized, seismologists will be interested to know that he had never wavered in his faith that there must be such a level in the deep interior (p. 526, under sulphur). So one could go on indefinitely. The book has something o value, not only for geologists and mineralogists, but also for scientific workers of every kind from oceanographers and soil chemists to crystallographers and astrophysicists. Moreover, the human significance of geochemistry is not forgotten. Practical applications to mining, metallurgy, chemical industry and agriculture are plentifully scattered through this most generously endowed book.

There will be widespread gratitude to Dr. Muir and his band of helpers for making possible the posthumous publication of this noble work, and to the publishers for a production of which Goldschmidt himself would have felt justly proud.

ARTHUR HOLMES

The Sources of Eddington's Philosophy

By Prof. Herbert Dingle. (Eighth Arthur Stanley Eddington Memorial Lecture, 2 November 1954.) Pp. vi+64. (Cambridge: At the University Press, 1954.) 3*s*. 6*d*. net.

THE annual Eddington Memorial Lecture is expected to discuss some topic which would have interested Eddington. It is not necessarily expected to discuss Eddington himself, and it is conceivable that the two tasks are mutually incompatible. Nevertheless, recollecting the antithesis to Eddington which Prof. Herbert Dingle maintained in the former's life-time, it is important to-day to read the considered judgment of ten years later. The old instinctive antagonism is there, the empiricist's mistrust of the purely rational share in scientific reasoning, a share which undoubtedly Eddington did over-emphasize. Dingle himself is not always to be acquitted of over-emphasis; for example, on p. 31: "I do not think that anyone but Eddington would have had the amazing combination of courage, perverted outlook and persuasive skill necessary to advance such an utterly fantastic notion".

What is novel and important in this lecture is a reclassification of some subjective and objective aspects of the internal and external worlds, which the author claims to draw from his critique of Eddington, but which, at least in shrewd and clear manner of statement, has here an originality of its own. It would be good to see in a future publication a *de novo* statement of Dingle's own situation concerning subjective elements in knowledge, without it being loaded by his disagreements with Eddington which tend to veil the development of genuinely original ideas.

But to read 'Dingle on Eddington' must always arouse a frustrated wish to have also an Eddington on Dingle; the great pioneer might possibly speak of his critic as in the latter's final words of this lecture: "He did not know what he was doing, but I believe that what he did was supremely great".

MARTIN JOHNSON

Probleme und Beispiele Biologischer Regelung

Von Prof. R. Wagner. Pp. viii+219. (Stuttgart: Georg Thieme Verlag, 1954.) 29.40 D. marks.

THIS book, the author of which is professor of physiology in Munich, is a discussion of biological processes from the point of view of servo-theory. Being a biologist himself, Prof. R. Wagner is fully aware of the fact that a major theme of physiology from the times of Claude Bernard and Ludwig up to the present day has been to discover and study biological self-regulations. The results of this work are readily available for those who want to rewrite the classical findings in terms of servo-theory.

Such pursuit in itself is an amusing intellectual exercise, and in this respect Wagner's book will not be found wanting. Criticism can only be levelled against its treatment of reflex self-regulations of the muscle contraction, a field in which so much new material has come to light within the past years that Wagner's discussion is obsolete. The author does not recognize antidromic regulations as a likely possibility. Yet most nervous centres are provided with recurrent collaterals, and the antidromic feed-back of the ventral horn cells is quite well understood. While in view of the general aims of the book this is not a serious criticism, it does, however, serve to emphasize the challenge of the experimenter, which is: What has servo-theory to offer as an aid to him in his work? Its mode of approach has now been presented many times to the biological world, propagandistically, but also unostentatiously, as in Wagner's book.

Would it be unfair to say that as a short-cut to experimental ingenuity servo-theory has not yet proved to be of much value compared with the resources of sound biological imagination? For the reply to this question the reader will have to turn to Wagner's work and judge for himself. Its author is a competent enough guide in both physiology and servo-theory.

British Pharmaceutical Codex, 1954

Pp. xxxii+1340. (Published by direction of the Council of the Pharmaceutical Society of Great Britain.) (London: The Pharmaceutical Press, 1954.) 63*s*.

THE first edition of the "British Pharmaceutical Codex" was produced by the Pharmaceutical Society in 1907; the fifth revision has now appeared after an interval of only five years and is thinner than its predecessor. This book differs from the "Pharmacopœia" by being less exclusive, so that it gives information about a wider range of drugs the status of which is in doubt, and by the inclusion of information about the actions and uses of drugs.

The new edition contains two hundred pages fewer than its immediate predecessor, and this change has been achieved by deleting many of the less reputable drugs, some of which are still used. The "Codex" is becoming a guide to the drugs which ought to be used and is losing its value as a guide to all the drugs which actually are used. If it continues to develop in this direction, the time may come when it will be fused with the "Pharmacopœia", and a new book will be started to provide official information, of a less ambitious kind, about all the drugs which are actually in use. In the meantime, the "Extra Pharmacopœia" provides a useful summary of unofficial views about unofficial drugs.

The Revision Committee is to be congratulated on the way it has performed a prodigious task in a short time. The new book contains a great amount of reliable information about recent advances in therapeutics and will be invaluable to all concerned with the practical art of curing the sick.

J. H. GADDUM

A Short History of Wool and its Manufacture (Mainly in England)

By E. Lipson. Pp. vii+205. (London: William Heinemann, Ltd., 1953.) 12*s*. 6*d*. net.

MOST of this book was published by the author thirty-three years ago as "The History of the Woollen and Worsted Industries" (London, 1921). In writing the present volume, he might have advanced our knowledge of the subject in two ways: by adding a satisfactory account of the wool trade and industry's progress during and since the nineteenth century; and by revising and extending his account of earlier periods in the light of work published by other scholars since 1921. As it is, the chapter on the nineteenth and twentieth centuries is sketchy and slight: the usual account of basic technological developments to about 1850; their effects upon hand workers (but why illustrate the condition of hand-loom weavers by material relating

to Bolton cotton weavers ?); and then a wild leap into the present century and a potted version of the Wool Working Party Report. For earlier periods, Mr. Lipson takes little account of material published since 1921 about wool textile history. Readers are directed to the bibliography of his 1921 publication, and there are no footnote references. The labours of more recent scholars have been in vain. The "Economic History Review" might never have been printed. To give one example, in spite of Prof. Carus-Wilson's account of an "industrial revolution" in the thirteenth-century woollen industry, written largely as a corrective to Mr. Lipson's earlier view of the period, we still find Edward III "reviving" this "decaying" industry.

The two new chapters on wool—English, merino and cross-bred—are interesting. The style of the book is easy to read; but for the serious student this pleasure is marred by the practice of quoting evidence without indicating its origin, or often even its date and author.

E. M. SIGSWORTH

Man Meets Dog

By Konrad Z. Lorenz. (Translated by Marjorie Kerr Wilson.) Pp. x+199. (London: Methuen and Co., Ltd., 1954.) 15*s*. net.

THE ability to write clearly and simply is not always coupled with high scientific attainments; when it is, books to remember result. We recall "King Solomon's Ring", a study of the animal mind, by Dr. Konrad Lorenz. The author now follows it with a volume on the dog, plus the cat, in the same lucid, humorous and unassuming style as its predecessor. He writes of the origin and domestication of the dog, its character, traits and conduct, in a variety of circumstances, including "the inviolable laws governing canine ceremonial, which determine the behaviour of stronger and weaker, of dogs and bitches". The cat, he says, is but a recent recruit and not really domesticated—that is, relatively to the dog, which may have been attached to mankind for 20,000–50,000 or 60,000 years. A word must be spared for the numerous and amusing drawings by the author and Annie Eisenmenges that adorn the pages. "Dog Meets Man" will bring enlightenment combined with pleasure to many readers.

FRANCES PITT

Four-Place Tables of Transcendental Functions

By Prof. W. Flügge. Pp. ii+136. (London: Pergamon Press, Ltd.; New York: McGraw-Hill Book Company, Inc., 1954.) 25*s*. net.

THIS book is mainly concerned with the tabulation of so-called 'non-elementary' functions, many of which were until comparatively recently the esoteric property of pure mathematicians and computers. To many engineers and physicists, they were little more than names, to be seen perhaps in the indexes of more advanced text-books and treatises on mathematical physics, and the few that came face to face with them in their problems were more often than not at a serious disadvantage owing to the extreme scarcity of numerical information concerning their values.

Modern technological developments, involving as they often do considerable incursions into 'non-elementary' mathematics, have created an essential and urgent need for tables of the functions involved, at any rate to what the author describes as slide-rule accuracy. Thus this book, to quote the preface, is intended to meet such requirements and "should be kept close to the slide-rule, in the middle drawer of the desk and not on the shelf".

Each section is prefaced by an adequate collection of relevant formulæ and bibliographical references to more elaborate and more accurate tables that might be required. Elementary functions are by no means ignored, and in the first two sections are to be found tables of trigonometrical functions in degrees and radians, hyperbolic and exponential functions and Naperian logarithms. The third and fourth sections contain tables of Bessel functions of both kinds, both simple and modified, and the ber, bei, ker and kei functions of Kelvin; the fifth deals with elliptic integrals of the first and second kinds and with all degrees of incompleteness. Finally, a miscellaneous section supplies tables of the error function, the gamma function, and the sine, cosine and exponential integrals.

J. H. PEARCE

Blood Groups in Man

By Dr. R. R. Race and Dr. Ruth Sanger. Second edition. Pp. xvi+400. (Oxford: Blackwell Scientific Publications, 1954.) 30*s*. net.

IT is four years since the first edition of Race and Sanger's book was published. In the intervening period an additional blood-group has been described (the Kidd-group), and the pace at which blood-group research is being prosecuted continues unabated.

This new edition is valuable, therefore, since it comprehensively reviews and describes the whole field of human blood-groups and brings us right up to date. There is, for example, an additional chapter on blood-groups and linkage; all this has made the volume bigger than the previous one. This new edition is superior to its predecessor, since it is better balanced and is written with a considerably more critical eye.

In spite of the wealth of information it contains, it is pleasant and easy to read.

This book has now become an established favourite and a standard work on the subject.

F. STRATTON

Biology of Deserts

The Proceedings of a Symposium on the Biology of Hot and Cold Deserts, organized by the Institute of Biology. Edited by J. L. Cloudsley-Thompson. Pp. iv+224. (London: Institute of Biology, 1954.) 14*s*.

THE papers read at the Conference on the Biology and Productivity of Hot and Cold Deserts which was organized by the Institute of Biology during September 1952 have now been published in one volume. The book is one of compelling interest not only for the skill in which its subject-matter has been chosen but also for the clear and lucid style of the many contributors. The papers themselves are grouped under the headings of climate and physical environment, plant ecology, entomology and ecology, economics and mammalian physiology and ecology; they include such varied topics as the microbiological formation of sulphur in Cyrenaican lakes, origin and development of insect plant pests in the oases of the French Sahara, and, somewhat surprisingly, the influence of climatic factors on the reaction of desert shrubs to grazing by sheep. Besides the papers, the book contains reports of the ensuing discussions; these again are gems of clarity and compression and add to the merits of a volume which should find many readers in biological and other circles. The editor may feel well pleased with his efforts.

CHEMICAL INDUSTRY AND AIR AND WATER POLLUTION

A SYMPOSIUM on "The Prevention of Atmospheric and Water Pollution in the Chemical Industry", organized by the London Section of the Society of Chemical Industry, was held at the Senate House, University of London, during April 4–5. A small exhibition in connexion with the symposium was arranged in the Department of Chemical Engineering, University College, London.

In a general introduction to that part of the symposium dealing with liquid wastes, Dr. B. A. Southgate, director of water pollution research, Department of Scientific and Industrial Research, discussed the possibilities of predicting the effects on a stream of discharging to it known quantities of an effluent which, by laboratory tests, had been found to conform to given standards of quality. From the results of tests for toxicity, it should be possible to predict with some confidence the direct effect of an effluent on a fishery. There would be much more uncertainty in predicting the effect of a liquor on the concentration of dissolved oxygen in a stream, since neither the rate at which oxygen would be dissolved from the air, nor the rate at which organic matter and ammonia would be oxidized by bacterial action, is known with any degree of accuracy.

After papers by Mr. J. A. Evans (Federation of British Industries) on the legal aspects of pollution and by Dr. S. H. Jenkins (Birmingham, Tame and Rea District Drainage Board) on the discharge of trade effluents to sewage purification works, the morning session closed with an important contribution by Dr. D. H. Sharp and Mr. A. E. Lambden, of Fisons Pest Control, Ltd., on the treatment of the waste waters from a factory making insecticides and fungicides and discharging its treated effluent to the Granta above Cambridge. The effluent—some fifty thousand gallons a day—before treatment contains dinitro-*ortho*-cresol, phenols, glycollic acid, secondary amines and copper, and is strongly coloured. It was known that organic nitro-compounds cannot readily be destroyed by bacterial action; this was found to be so, for example, during the War, when methods were sought for disposing of liquors containing picric acid and dinitrophenol from shell-filling factories.

The method of treatment adopted by the firm is to pass the liquor, under acid conditions, through beds of activated charcoal, where most of the dinitro-*ortho*-cresol and phenols, and part of the glycollic acid and amines, are adsorbed. Copper is then removed by adding lime; a precipitate, mainly of calcium sulphate and phosphate, separates, and this on settling carries down the copper with it. The well-known method of displacing copper from solution by treatment with metallic iron was not adopted because of the lengthy period of contact, and thus the large plant, required. After dilution with river water, final effluent and the factory sewage, the liquid is passed through percolating filters, where the concentrations of the remaining phenols and glycollic acid are reduced by 90 per cent and 80 per cent, respectively; finally, the liquid is aerated in a tank, passed through a sedimentation tank, and discharged. Taking into account the apparent intractability of the original liquor, the effluent is of very good quality. The cost, however, was given as £1 per 1,000 gallons—an example of the great expense to which a manufacturer may be put if he has to treat a difficult waste water to yield an effluent of sufficiently high quality for discharge to a small stream.

Dr. W. H. Blackburn (Joint Research Committee of the Gas Council and the University of Leeds) discussed the problem of disposing of liquors from gasworks—about 1,300 million gallons of these liquors are produced annually in the United Kingdom. The general line of attack is to make such changes in the methods of purifying gas at a gasworks as will facilitate the subsequent treatment of the liquor, and then to discharge this liquor, wherever possible, to a domestic sewer for treatment in admixture with sewage at a sewage works. Thus, the concentration of thiocyanate in gas liquor can be kept low by restricting oxidation of ammonium sulphide to polysulphide (which reacts with cyanide to give thiocyanate) and various measures—including removal of tar from the hot gas by electrostatic precipitation—can similarly be taken to reduce the concentration of polyhydric phenols and other complex acidic substances which are difficult to destroy by bacterial action. Treatment of gas liquor by itself is at present very expensive—the cost at a plant at the Tingley works of the North Eastern Gas Board, for example, is £2 10*s*. per 1,000 gallons.

In a paper on waste waters containing cyanides, Mr. A. E. J. Pettet and Dr. G. C. Ware, of the Water Pollution Research Laboratory, Department of Scientific and Industrial Research, described the two most frequently used chemical methods of treatment, namely, precipitation of insoluble complexes with iron and the more efficient process of oxidation by chlorine to cyanogen chloride, which then hydrolyses to cyanate. Both these methods are used on a large scale, but they require accurate control and are somewhat expensive to operate; there is thus much interest in the recent discovery that relatively high concentrations of simple cyanides, and of some complex ones, can be destroyed by biological filtration. The organism responsible, which appears to be an Actinomycete, converts cyanide almost quantitatively to ammonia, which in a percolating filter is then oxidized by other organisms to nitrite and nitrate.

In the paper and board industry (Mr. R. D. Isabell, British Paper and Board Industry Research Association) and the sugar beet industry (Mr. O. H. Phipps, British Sugar Corporation, Ltd.) the problems of disposing of effluent are somewhat similar in that, in both, success depends on reducing so far as possible the discharge of oxidizable matter with the waste waters. In paper mills, where raw material such as esparto is digested with caustic soda, something like half the weight of organic matter in the raw material is dissolved. The lye is then separated from the pulp, concentrated in vacuum evaporators, and burned to yield sodium carbonate, which, after causticization with lime, is re-used in the process. An important problem, therefore, is to separate the liquor from the pulp, and to wash the pulp free from adhering liquor, while using as little water as possible so that the whole of the liquor and washings can be evaporated

economically for soda recovery. The industry's research association is working to improve the efficiency of the washing process; but in many mills the design of the digestors is such that an efficient closed counter-current system of washing cannot be employed.

In the sugar beet industry, if all the waste waters were discharged, extremely large and costly plant would be required to treat them. In theory, the volume of effluent can be reduced by about 98 per cent by re-using the three types of waste water—process water, transport water and condenser water—in separate circuits in the factory. Mr. Phipps reported that at many beet-sugar factories in Britain the volume of liquid discharged for treatment now closely approaches this minimum. This residual liquid is stored in lagoons, where it undergoes some purification by biological action, and can finally be treated in percolating filters to yield an effluent of quite good quality. Re-use of what were previously 'waste-waters' in the factory has given rise to some difficulties—for example, corrosion has been increased—but these are being overcome, and it is evident that the problem of disposing of the effluent from the beet sugar industry, which at one time appeared to be so intractable, is well on its way to solution.

Proceedings on the second day related to the abatement of air pollution by the chemical and allied industries, and were opened by Sir Hugh Beaver, who referred to the need for measures to be taken to give a cleaner air, and compared and contrasted the position as he saw it in the United States and in the United Kingdom.

W. A. Damon (chief alkali inspector, Ministry of Housing and Local Government) dealt with the operation of the Alkali Act, mentioning that it is usually the treatment of large volumes of gas containing a relatively low concentration of a noxious constituent that poses the greatest problems. After referring to the washing of power-station gases and the factors governing dispersal of chimney emissions, he went on to deal with the specific cases of emissions from petroleum refineries, blast furnaces, Bessemer convertors, open-hearth furnaces, coke ovens and gasworks, clay firing, lime burning and the extremely difficult problem of fluorine emissions from the aluminium, clay and steel industries. He stressed that many of these problems will be resolved by time and patience, and that panic measures should be avoided. Industry should realize that there will be an insistent demand for the abatement of pollution and that some of the remedial measures must be a charge on the process.

The zinc industry made its major contribution to a purer air some thirty years ago when roaster gases were diverted from direct emission to air to conversion to sulphuric acid by the contact process. E. Wallis (Imperial Smelting Corporation, Ltd.) described the efforts made in recent years by the industry to increase production on existing plant without increase in air pollution. These related to improved collection of dust from the sintering machines by application of a Venturi-type scrubber, and to reduction in the acidity of the waste gases from the contact acid plants by scrubbing with ammonia, with production of ammonium sulphate as a by-product.

Emissions from superphosphate works were dealt with by K. A. Sherwin (Fisons, Ltd.). After discussing the emissions from the chamber or contact acid plants, now an essential part of any large fertilizer works, he went on to deal in some detail with the treatment of the silicon fluoride evolved in the production of superphosphate. The acidity of the gases is reduced to a very low figure by washers of conventional design; but the disposal of the liquid effluent of hydrofluosilicic acid mixed with gelatinous silicic acid would be a major problem were not the majority of fertilizer factories necessarily situated on tidal water. The bulk of superphosphate made is now mixed with other fertilizer salts to give various compound fertilizers, most of which are prepared in granular form. Granulation leads to appreciable dust emission, which necessitates the installation of cyclones followed by water-fed scrubbers. Production of triple superphosphate by action of phosphoric acid on phosphate rock gives rise to emission of silicon tetrafluoride, which can be dealt with on routine lines.

Most of the sulphur fed to the viscose process of rayon, etc., manufacture is emitted to air as carbon disulphide and hydrogen sulphide in concentrations at staple fibre factories of 800 and 300 p.p.m., respectively. D. C. F. Pratt and Dr. A. Rutherford (Courtaulds, Ltd.) described the experiments leading up to the construction and the ultimate operation of a large prototype scrubber whereby the hydrogen sulphide content of the waste gases was reduced to 10–20 p.p.m., and the carbon disulphide reduced by 50–70 p.p.m. This was effected by application of the 'Ferrox' process, whereby the contaminated air is scrubbed by an alkaline medium containing a suspension of hydrated ferric oxide, the absorbed sulphide being then converted to sulphur and the iron oxide regenerated by aeration.

A. Jackson and J. M. Solbett (Simon-Carves, Ltd.) dealt with the problem of the tail gases from contact sulphuric acid plants. In the years immediately following the War, the four-stage units burning brimstone were operated with a conversion efficiency of 98 per cent. Since 1950, however, a large programme of construction of pyrites-burning plant has been undertaken, and here, because of the lower oxygen to sulphur dioxide ratio, conversion efficiency is necessarily lower and the acidity of the escaping gases consequently higher. Reduction in acidity can be effected by water washing, in a few cases where there is a demand for the bisulphite produced by scrubbing with alkali, by the basic aluminium sulphate process or the sulphidine type of process using aromatic amines, or more usually by the ammonia process whereby ammonium sulphate is produced as a by-product. A problem at plants burning brimstone, especially when of high bitumen content, is that of acid mist in the final escape, and electrostatic precipitation seems the most practicable remedial technique.

E. Burke, director of research for the Associated Portland Cement Manufacturers, Ltd., referred to the problem of dust arrestment in the expanding cement industry. The difficulties are related to the enormous volume of kiln gases to be treated and the high moisture content, which carries with it the hazards of condensation and corrosion. He reviewed the three possible methods of dust arrestment—high-duty cyclones, electrostatic precipitation and water washing—and described the design of an electrostatic precipitator evolved as a result of long experience to minimize the hazards of condensation, corrosion, etc., and to be operative at high efficiency

for long periods. He then described the technique of isokinetic sampling at various points in the ducting, so as to determine with reasonable accuracy the dust burden of gases.

A major carbon-black industry is a post-war development, and its installation in the United Kingdom where there are no wide open spaces has led to the development of the elaborate technique described by D. L. H. Allan (Philblack, Ltd.). The manufacture is, of course, a deliberate attempt to produce 'soot'. The soot-laden gases from the burning of a petroleum oil fraction under controlled conditions are taken to electrostatic precipitators, which act essentially as agglomerators, rendering the 'black' capable of arrestment by cyclones. Any residual 'black' in the off-gases is then removed by water scrubbing followed by wet electrostatic precipitation or by bag filtration. The off-gases still contain enough hydrogen sulphide to be offensive and are disposed of by flaring or burning in a special furnace.

C. J. Stairmand and R. M. Kelsey (Imperial Chemical Industries, Ltd., Billingham Division), taking as typical examples of cyclones the Scroll collector, the high-throughput cyclone, the high-efficiency cyclone and the multicyclone, dealt with the uses to which these can be put as arresters of grit and dust and outlined the procedure for predicting their performance. Cyclones can also serve an extremely useful purpose in reducing the load on more expensive and elaborate secondary collectors; for example, the use of high-efficiency cyclones in connexion with electrostatic precipitators is well known.

Discussion of the various papers related mainly to elaboration of miscellaneous points, and it was noticeable that those papers dealing with visible pollution—cement, grit, carbon black—produced the longer discussions.

THE EXPERIMENTAL APPROACH TO THINKING

WHEN the old Persian philosopher Avicenna, a thousand years ago, felt perplexed and unable to follow a syllogism, he would go to the mosque and pray for his understanding to be opened and his difficulties to be smoothed away. If he were with us now, we could scarcely offer him wiser counsel. The charge made by Graham Wallas a quarter of a century ago that when the text-books of psychology pass from the simpler to the more elusive mental processes "they become in almost every case entirely useless" is almost as pertinent to-day. This is not the place to meditate on the possible causes of this sad state of affairs; but we can feel much sympathy with Sir Frederic Bartlett's aim, in his Friday Evening Discourse given at the Royal Institution, London, on March 4, to use the experimental method in the hope of casting a ray of light on the darkness of our thoughts. He would be content if he could demonstrate that problems of human thinking can fruitfully be made a subject for experiment; but he would not wish to imply that an experimental approach to the study of thinking is new. Four years ago, Prof. G. Humphrey, in a scholarly work[1], gave an account of a variety of such studies extending over a period of half a century, from the Würzburg School onwards; and in our laboratory at Manchester we have for some time been pursuing the experimental study of thought.

Sir Frederic takes his point of departure from long experience in the investigation of skill and declares that thinking "is in the order of skilled behaviour" in which symbols of various kinds rather than bodily movements are employed. He cites interesting examples from everyday life in which skill in filling a gap is required, such as, for example, when a page is missing from a book we are reading or when, in tracking a target, we lose it for a time and then pick it up again.

He maintains that his analogy between thought and skill is "the most reasonable suggestion and the one most closely in agreement with evidence of a general character". The suggestion, he believes, is also convenient because of recent advances in our knowledge of skills. He does not, however, tell us why it is the most reasonable suggestion, nor does he indicate the general evidence to which he refers.

Sir Frederic observes that bodily skill begins with some outside signal and is "commonly sustained by a succession of such signals". But is not the characteristic feature of thought that it is essentially a central process, *not* sustained by outside signals? If so, the analogy between skill and thought may perhaps not be as fruitful as appears at first sight.

All his proposed experiments are of a similar type or form. Evidence or information is presented to the subject with gaps in it, and in such a way "that the gaps must be filled up by a sequence of related steps or moves". The problems vary in complexity and in the number of items of information provided. At one extreme, the subject is given, say, the digits 1, 3, . . . 17 and asked to fill in the missing items. At the other extreme, a passage is presented describing results of experiments concerned with the effects of temperature on sensitivity, and the subject has to answer certain questions about the conclusions established by the evidence. As examples of intermediate problems we may take as one case where the subject is given the sets 1 2 3 4 : 2 1 3 4 : 2 1 4 3, and has to continue to change the positions of the numbers until he reaches the final arrangement that seems to be aimed at; another example is where the subject is given sixteen letters of the alphabet set out in random order and has to answer the following questions: If any of these letters is chosen at random, how many questions need I ask in order to discover which it is? What are the questions? Put them in order.

Sir Frederic believes that the underlying experimental pattern is quite general and capable of being applied equally to popular and to scientific systems of thought. He employs the idea of 'directionality' in a sense different both from that of N. R. F. Maier and from the earlier Würzburg idea of 'determining tendency', defining it in terms of "more or less regularly increasing probability of next step". It is not clear, however, how this probability is itself to be measured in the experimental situation. Nor is it clear why Sir Frederic thinks it 'certain' that the storage of information (or memory) does not impose 'directionality' upon it. Do not his own distinguished researches on remembering suggest the contrary?

The belief, which Sir Frederic seems to approve, that thinking is "tied up with the solution of problems" may be seriously questioned. It does not appear to be necessary for Sir Frederic's proposals and it is a pity that he has not criticized it. The cliché—so often met in the American text-books—that "thinking is problem-solving" overlooks the fundamental portion of our thinking which has to do with the detection or identification of problems. The very word 'problem' is hard to pin down to any useful meaning, and in much of our thinking we are groping to find out *what* needs to be done rather than *how* it needs to be done.

Whenever we consider experiments in psychology, we should see them in perspective and recognize that there are other methods just as important. Without in any way diminishing the value of Sir Frederic's suggestions about thought and skill, we have to bear in mind that most illuminating insights into thinking have come from men gifted with an intuitive understanding of their own mental life, from novelists and poets like Proust and Keats, as well as from men of science and mathematicians like Helmholtz, Poincaré, Graham Wallas and Hadamard. Above all, we are indebted to Freud for a far-reaching conception of thought which is at once biological in character and based on profound clinical observation. The scope of the psychology of thought must cover the developmental sequence of mental growth, pathological thought, as well as comparative studies in different cultures. In these spheres, it is vital to supplement experiment with other methods of inquiry. Sir Frederic's proposed experiments are drawn from his interest in skill. A full programme of experimental inquiry into thinking must be founded upon a deep understanding of the characteristic features of thought during the period of development, of non-conscious thought structures, of the psychopathology of thought and of social and cultural influences on thinking. JOHN COHEN

[1] Humphrey, G., "Thinking: An Introduction to its Experimental Psychology" (Methuen, London, 1951).

A NEW ÆTHER-DRIFT EXPERIMENT

By DR. L. ESSEN

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THE special theory of relativity is so well established by indirect evidence that the significance of the original æther-drift experiments has decreased, and the experimental discrepancies in the results obtained have caused few misgivings. Such discrepancies should, however, be examined if further developments in experimental technique enable new and possibly more precise methods to be employed.

The possibility of performing an experiment similar to that of Michelson and Morley but using short radio waves in place of light waves has been discussed in several letters in *Nature*[1–4], and the experiment outlined in one of these[3] has now been completed at the National Physical Laboratory.

A cylindrical cavity resonator of length 16·866 cm. and diameter 8·075 cm. was used to control the frequency of an oscillator at approximately 9,200 Mc./s. The resonator was mounted with its axis horizontal and was rotated continuously in a horizontal plane at a rate of about one turn per minute, the frequency of the oscillator being measured by comparison with a quartz standard at intervals of 45° during the rotation.

The theory of the method may be described in the following way in order to bring out the points of similarity to the optical method. The cavity resonates when its length is a whole number of half-wavelengths and the resonant frequency is given by:

$$f = \frac{v}{\lambda} = \frac{nv}{2l}$$

where v is the phase velocity, λ the wave-length, l the length of the resonator and n the number of half-wave-lengths. In this condition the time taken for the phase of the wave to travel to and fro between the end faces of the resonator is $1/f$. If now because of the earth's orbital motion a relative velocity q be postulated between the resonator walls and the medium of propagation within it, then just as in the optical case, this time becomes:

$$t_1 = \frac{2l}{nv}\left(1 + \frac{q^2}{v^2}\right)$$

when the axis of the resonator is in line with the orbital motion, and:

$$t_2 = \frac{2l}{nv}\left(1 + \tfrac{1}{2}\frac{q^2}{v^2}\right)$$

when it is at right angles to it. The resonant frequency and therefore the frequency of the controlled oscillator should thus vary by a fractional amount of $q^2/2v^2$ on rotation, there being two minima and two maxima for a complete rotation of 360°.

In the optical experiment, interference fringes are formed between two beams of light which have followed paths at right angles to each other. On rotation of the interferometer through 90°, the positions of the paths are interchanged and the difference in transit time is reversed, giving a fractional change of q^2/v^2 which is observed as a fringe displacement. Another difference from the present experiment is that whereas the phase velocity of the light waves is very nearly equal to the free space value c, it is greater than c for the radio waves and depends on the diameter of the cylinder in which the waves are travelling. The calculated frequency-change is accordingly only 3 parts in 10^9 for the resonator and frequency employed if the earth's orbital velocity is taken as 30 km./s., while the corresponding fractional time change in the optical method is 1 part in 10^8.

The results obtained are summarized in Table 1, which gives the average of each set of observations reduced to a convenient form by a correction for linear drift and the subtraction of a constant term.

In the last column is given the amplitude of the second harmonic periodic term as determined by harmonic analysis. The figures in the last line are obtained by averaging the observations for every rotation and not by averaging the mean figures given above. The averaging is permissible because the

Table 1. Variation of Frequency with Rotation of the Cavity Resonator
Date of measurement, December 3–15, 1954. Unit, 1 c./s. (1·09 parts in 10^{10})

No. of rotations	Deviation of resonator frequency from the reference value at orientation								Amplitude of 2nd harmonic term
	0°	45°	90°	135°	180°	225°	270°	315°	
12	9·1	41·8	59·7	60·9	36·1	0·8	−16·5	−22·2	0·55
7	1·2	22·2	45·6	37·7	18·8	10·0	− 6·3	−12·6	2·5
12	2·5	32·3	57·8	43·5	24·2	− 6·3	−30·4	−24·9	0·8
22	9·6	18·0	19·6	13·6	9·7	4·6	− 5·7	− 0·8	1·2
15	6·7	47·2	67·8	49·4	20·4	−31·0	−42·4	−22·4	1·4
22	6·5	33·5	47·8	42·6	9·0	−28·9	−38·5	−27·0	1·6
14	5·8	36·2	52·6	42·0	7·8	−25·0	−40·6	−30·4	0·2
14	−1·6	3·7	4·6	6·8	2·9	− 3·0	− 6·2	− 5·7	0·4
Total 118	0·9	23·3	36·9	29·3	9·4	−15·5	−27·4	−20·9	0·1

Table 2. Variation of Frequency with Rotation of the Cavity Resonator, Individual Observations
Unit, 1 c./s. (1·09 parts in 10^{10})

No. of rotation	Deviation of resonator frequency from the reference value at orientation							
	0°	45°	90°	135°	180°	225°	270°	315°
1	− 19·0	10·5	17·0	18·5	13·0	6·5	0	− 25·5
2	5·5	28·6	11·7	− 0·2	4·0	− 9·9	− 23·8	− 11·2
3	5·0	10·5	6·0	1·5	− 3·0	− 7·5	− 12·0	− 6·5
4	− 19·0	− 6·7	13·6	29·8	18·0	8·3	4·5	− 27·2
5	5·0	5·0	− 5·0	− 10·0	− 15·0	0	5·0	10·0
6	5·5	4·5	3·5	2·5	− 1·5	− 9·5	− 5·5	3·5
7	− 3·0	0·1	3·2	21·3	− 0·6	− 7·4	− 4·3	− 1·2
8	− 1·0	− 3·5	4·0	− 4·5	− 6·0	− 3·5	− 1·0	− 3·5
9	− 10·0	− 10·0	− 5·0	0	10·9	15·0	5·0	0
10	− 5·0	− 8·1	3·8	0·7	7·6	4·4	1·3	− 1·8
11	− 1·0	7·1	5·2	8·3	11·4	− 0·4	− 12·3	− 14·2
12	− 5·0	5·6	11·2	11·8	17·1	− 6·8	− 20·2	− 15·6
13	18·0	− 0·1	− 16·2	3·7	0·5	− 7·6	− 10·8	1·1
14	2·0	8·9	10·8	12·7	− 15·5	− 23·6	− 11·8	12·0
Average	− 1·6	3·7	4·6	6·8	2·9	− 3·0	− 6·2	− 5·7

observations were all made at about the same time of day. It will be noticed that there is a much larger periodic variation, having one maximum and one minimum per rotation. This was found to be due to a tilt of the turntable and was difficult to remove for reasons explained later. It was least in the last set of measurements, and the individual observations for this set (again corrected for linear drift) are given in Table 2 to illustrate the precision of measurement achieved.

The experiment was performed with existing apparatus and was completed within a few weeks of its assembly. Some of the practical difficulties that were met could probably have been overcome by the construction of special equipment, but others were of a more fundamental nature.

The cavity resonator was made of invar to secure the low temperature coefficient required in its original application[5], and preliminary tests were therefore made to determine the effect of magnetostriction on the oscillator frequency. The changes of frequency observed on applying magnetic field-strengths between 1 and 10 gauss suggested that the earth's field would produce a periodic change with rotation of about $\pm 2 \times 10^{-11}$, and this could account for the second harmonic term in the results given in Tables 1 and 2.

The turntable, which was adapted from the base of a fatigue testing machine by Messrs. H. L. Cox and N. B. Owen, carried the whole apparatus, including the resonator, the oscillator control circuits and the frequency standard, weighing altogether approximately 5 cwt. It was mounted on rollers and driven through a reduction gear by an electric motor; and a certain amount of gear vibration and non-uniform acceleration was detected. The effect of the vibration was reduced by mounting the oscillator on sponge rubber, but this accentuated the effect due to a tilt of the turntable to which reference has already been made.

The principal practical difficulty was, however, the adjustment of the oscillator to have the necessary small band-width and stability. Under the conditions accepted for observations, the band-width was such that a single comparison of frequencies in terms of the standard could be made with a precision of ± 1 part in 10^{10}; but when the apparatus was rotating, this condition was not maintained for very long. If the stability of the oscillator could be increased, it might be worth while repeating the experiment with an improved turntable and with the magnetostriction effect eliminated by screening or by using a cavity resonator of different material.

It may be of interest to recall the most recent optical results. In the precise determination made by Joos[6], the interference fringes were measured by a microphotometer and it was concluded that there was a null result to $\pm$ 0·001 fringe or 0·3 per cent of the expected displacement. Miller[7], however, who carried out the most extended measurements, was critical of this result and afterwards published a paper in which he persisted in his view that there is a definite effect of about 8 per cent of that anticipated. The present experiment suggests that Miller's conclusions cannot be accepted; the effect, if any, is shown to be not more than one-tenth of that reported by him, which must probably be ascribed to some systematic error[8].

The work described above has been carried out as part of the research programme of the National Physical Laboratory, and this paper is published by permission of the Director of the Laboratory.

[1] Littman Furth, H., *Nature*, 173, 80 (1954).
[2] Essen, L., *Nature*, 173, 734 (1954).
[3] Littman Furth, H., *Nature*, 174, 505 (1954).
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OBITUARIES

The Rev. Pierre Teilhard de Chardin, S.J.

FATHER TEILHARD DE CHARDIN, whose death occurred on April 10 at the age of seventy-four, was noted for his substantial contributions to mammalian palæontology (with particular reference to Palæocene and Eocene genera) and for his geological and archæological studies in the Far East. His scientific career may be said to have started in 1903 in Jersey, where he was studying philosophy, for while there he published a few notes on the mineralogy of the island which appeared in a local journal. Then, after a period of two years at the Collège de la Sainte Famille in Cairo as lecturer in physics and chemistry, he was sent to a Jesuit College at Hastings to pursue theological studies. It was while there that he assisted in the excavations at Piltdown and later found the canine tooth which was presumed to belong to 'Piltdown man' (though he himself took no part in the study of these alleged fossil specimens).

From 1914 onwards, de Chardin published a series of excellent monographs in the *Annales de Paléontologie* on fossil mammals from Tertiary deposits in France and Belgium. These dealt mainly with the Carnivora and Primates, and among the latter he described one of the earliest known anaptomorphids, which in some of its characteristics proved to be (apart from tupaioids) the most generalized and most primitive of all known Primates. He supposed this early Primate to be congeneric with the American type *Omomys*; but Simpson showed later (1940) that it was a distinct form and, in honour of its discoverer, renamed it *Teilhardina*.

In 1922, Teilhard de Chardin was elected president of the Geological Society of France, and in 1923 he went to the Far East, where for a number of years he took part in geological expeditions organized by American universities and the American Museum of Natural History. His work in China was particularly noteworthy for the detailed records which he made of the sequence of Tertiary deposits in that part of the world. As a result of these observations, he was able to establish important stratigraphical correlations between the different regions of China, and between these regions and India and Burma. He also extended his studies of fossil mammals to include the Pliocene Camelidae, Giraffidae and Cervidae of South-east Shansi, Pliocene and Pleistocene rodents from North China, and a collection of Miocene cervids from Shantung. From the sites at Choukoutien where remains of *Pithecanthropus* (= *Sinanthropus*) had been found, he described a number of the associated mammals, and then turned his attention more particularly to a stratigraphic examination of the cave deposits and a study of the lithic industry found in relation to the human remains. The stratigraphy of the deposits posed a difficult problem because of the complicated fissuration of the limestone formations; but Teilhard de Chardin adduced a considerable amount of evidence to show that the fossiliferous strata were older than the loessic formation of China but younger than the uppermost Pliocene beds of Nihowan.

Teilhard de Chardin's palæontological publications are all characterized by a clarity of style combined with conciseness of description. He also had a facility for designing illustrations which were particularly effective in their simplicity, in the sense that they immediately focused the attention of the reader on the morphological essentials of the specimens which he described. Almost up to the time of his death, he continued to maintain a very active interest in palæontology. W. E. LE GROS CLARK

Dr. Julius Podolanski

DR. JULIUS PODOLANSKI, senior lecturer in theoretical physics in the University of Manchester, died suddenly on April 12. He was born in Poland in 1905 and his family moved to Germany while he was an infant. He read physics and mathematics at Leipzig and Jena, obtaining the degree of Dr.Phil. of the latter University. Because of the Nazi attitude towards Jews, he was unemployed for a long time in the 'thirties, but eventually found work as a reader with the publishing firm Akademische Verlagsgesellschaft. One of his tasks was to read a proof of Prof. H. A. Kramers's book on quantum mechanics. He did not confine himself to purely technical corrections but detected some actual mistakes in the treatment of the subject. Kramers was so struck by this criticism that he inquired about such an unusual corrector. The result was that Kramers arranged for Podolanski to join him in Leyden in order to assist in the research work of his Department.

Podolanski went to Leyden in 1939; but after the German invasion of Holland he was forced to leave the coastal area and went to Utrecht, where he lived on a small stipend. He was officially forbidden to go to the University because of his race; but seminars were held at my house in order that Podolanski could attend. As the War went on even this difficult way of life became impossible and he was driven into hiding. For a time he carried forged papers and lived alone in an isolated windmill. After the liberation he became my assistant at the University of Utrecht and rejoined me in Manchester in 1948. Shortly before coming to England, he married a Dutch student, Marietje van Rossem, who had courageously helped him while he was in hiding.

Podolanski's scientific activity was originally centred on the more abstract aspects of the theory of fields. He had a thorough and profound knowledge of the general theory of relativity and of the geometrical disciplines connected with it. However, his interests covered the whole range of physics, and he always found time and energy to discuss the most varied problems with research students and colleagues at the different places where he worked. A great reserve and somewhat exaggerated propensity to self-criticism prevented him from publishing the results of his investigations, and apart from the few papers which he was persuaded to publish, the only testimonials to his unceasing activity are the many acknowledgments of his help and inspiration that appear in the papers of other authors. His work on unified field theory in six dimensions published by the Royal Society is one of the most original contributions to this somewhat abstract subject. It is typical of his versatility that another of his significant contributions is the elaboration of a method for the analysis of cloud-chamber photographs of heavy mesons.

Podolanski was outstanding as a teacher; his devotion to his students was unexampled. In fact, he was incapable of refusing any request for help or guidance even when this help was given at the expense of his own investigations. His interest in people showed itself most strikingly by the way

in which he gave any casual group of research workers a sense of belonging to a lively and friendly community. Passing visitors enjoyed the hospitality which he and his wife were always ready to offer; they left as lasting friends. Everyone who in any way came into contact with him will ever remember his colourful and lovable personality.

L. Rosenfeld

NEWS and VIEWS

Foreign Members of the Royal Society

The following have been elected foreign members of the Royal Society:

George Washington Corner (Baltimore), distinguished for his work on the endocrine control of gestation and especially on the function of the corpus luteum in mammals;

Werner Heisenberg (Göttingen), distinguished for his basic contributions to quantum theory;

Lise Meitner (Stockholm), distinguished for her fundamental discoveries in radioactivity and nuclear physics;

Otto Renner (Munich), distinguished for his researches in plant physiology and nuclear and cytoplasmic genetics.

Rumford Premium of the American Academy of Arts and Sciences

The Rumford Medal and Premium for 1955 of the American Academy of Arts and Sciences has been awarded to Prof. James Franck, professor of physical chemistry in the University of Chicago. The award was established in 1796 by Benjamin Thompson, Count Rumford, to be given to "the author of the most important discovery or useful improvement on heat or on light", and was first given in 1839. Prof. Franck was formerly professor of physics and director of the Physical Institute in Göttingen, Germany. In 1925 he shared the Nobel Prize in Physics with Gustav Hertz. He left Germany in 1933 and began a new scientific career in the field of photosynthesis, first at Johns Hopkins University and later at the University of Chicago. Since Rumford stipulated that the Premium be granted for discoveries made and published upon the American continent, it has been specifically awarded to Prof. Franck for his important contributions to photosynthesis, both theoretical and experimental.

Royal Aeronautical Society: Awards

Honorary fellowship of the Royal Aeronautical Society has been conferred on Dr. Igor I. Sikorsky and on Mr. H. Grinsted. The following awards have been made by the Society: *R. P. Alston Memorial Prize*, G. A. V. Tyson, for contributions on flight testing of marine aircraft; *Edward Busk Memorial Prize*, J. C. Wimpenny, for a paper on the stability and control in aircraft design; *Herbert Akroyd Stuart Memorial Prize*, E. E. Chatterton, for a paper on compound diesel engines for aircraft; *Usborne Memorial Prize*, L. F. Crabtree, for a paper on the compressible laminar boundary layer on a yawed infinite wing; *Orville Wright Prize*, D. B. Spalding and B. S. Tall, for their paper on flame stabilization in high-velocity gas streams and the effect of heat losses at low pressures; *J. E. Hodgson Prize*, jointly to Major G. P. Bulman, for the first Barnwell Memorial Lecture, and J. Smith, for the first Mitchell Memorial Lecture; *Branch Prize*, E. Chambers, for a paper on meteorological services for the *Comet*; *Royal Aeronautical Society Navigation Prize*, J. F. W. Mercer, for a paper on a quantitative study of instrument approach. Two awards will be made from the Society's *R.*38 Memorial Fund: to Lord Ventry, to assist him in the carrying out of experiments and to help in the development of the airship *Bournemouth*; and to W. N. Alcock, to assist him in his further investigations in connexion with airships.

Honorary Associates of the City of Birmingham College of Technology

At a ceremony on April 30, celebrating the diamond jubilee of the City of Birmingham College of Technology, honorary associateship of the College was conferred on the following: Dr. James C. Duff, formerly head of the Department of Chemistry of the College; Sir Leonard Lord, chairman of the British Motor Corporation; Sir Frederick Handley Page, chairman of Handley Page, Ltd.; Mr. A. B. Waring, chairman and managing director of Joseph Lucas, Ltd.; Lieut.-General Sir Ronald Weeks, chairman of Vickers, Ltd.; and Mr. T. Williamson, general secretary of the National Union of General and Municipal Workers.

Bohuslav Brauner (1855–1935)

Bohuslav Brauner, who was born in Prague one hundred years ago on May 8, 1855, was descended on his mother's side from a family eminent in chemistry and in pharmacy. Accustomed from an early age to speaking English, French, German and Russian at home, he became a remarkable linguist. He was educated at the local university and technical school and, after working with R. W. Bunsen at Heidelberg, he studied under Sir Henry Roscoe at Manchester, being particularly interested in the rare elements. In 1881 he was elected to a Berkeley fellowship at Owens College, Manchester, and began to correspond with D. I. Mendeléeff, whose periodic system of grouping the elements aroused his admiration; the two became lifelong friends. Brauner succeeded in preparing a double fluoride of tetravalent cerium and potassium, which on gentle heating gave off free fluorine—the first time this had been obtained by purely chemical means. He was appointed lecturer in chemistry at the Charles University in Prague in 1883, assistant professor in 1890 and full professor in 1897. He was a voluminous writer, and contributed the section on the rare earths for Mendeléeff's "Principles of Chemistry" and a critical discussion on atomic weights to Abegg's "Handbuch der Anorganischen Chemie". The new base, O = 16·000, long advocated by him, was generally adopted at the Paris Congress in 1900. Brauner was a man of giant frame, commanding voice and sarcastic wit; his interest in various sciences included a special one in astronomy. An honorary D.Sc. of the University of Manchester and an honorary Fellow of the Chemical Society (London), he retired in 1925 after completing forty-three years of teaching, and died of pneumonia on February 15, 1935, in his eightieth year.

B.B.C. Services on Very High Frequencies

For some time past it has been the policy of the British Broadcasting Corporation to inaugurate sound broadcasting services in Britain in the very-high-frequency band of 88–95 Mc./s. (see *Nature*, 173, 248; 1954). In its second report the Television Advisory Committee (1952) recommended the adoption of frequency modulation for such very-high-frequency broadcasting and stated that the B.B.C. was ready to start the construction of the necessary stations for the Home Service. In July last year the Postmaster-General announced that the B.B.C. could proceed with the first stage of its plan, and he approved the installation of the first nine stations, which, it is estimated, will eventually provide a three-programme sound broadcasting service to about 75 per cent of the population in Britain. The purpose of very-high-frequency transmissions is to reinforce the existing medium-wave and long-wave services, reception of which is becoming difficult for many listeners because of the increasing interference from foreign stations and from electrical appliances of various kinds.

The first of the new transmitting stations, using frequency modulation, was brought into service at Wrotham, Kent, some twenty-three miles south-east of London, on May 2. The three programmes are on the following frequencies: the Light Programme, 89·1 Mc./s.; Third Programme, 91·3 Mc./s.; and the Home Service, 93·5 Mc./s. The effective radiated power is 120 kW. in each case, and the transmissions are horizontally polarized. The station will serve the London area and the south-east of England within a range of about fifty miles. The B.B.C. built Wrotham in 1950 as an experimental station with two transmitters to enable the problems of high-power very-high-frequency transmissions and their reception to be studied. The third transmitter, which has more recently been built, carries the Home Service and differs from the two already installed in that it is built as two separate units for operation in parallel, with each unit capable of maintaining the service at reduced power in the event of a fault on the other. For the first few weeks, only one of these transmitter units will be in operation, and the Home Service transmissions will not be at full power; the effect of this is not likely to be noticeable except at extreme range.

William Ramsay Centenary Appeal

In 1952, a hundred years after the birth of Sir William Ramsay, an appeal for £100,000 was launched with the following two objects: to construct additional laboratory accommodation in Ramsay's old Department of Chemistry at University College, London; and to make an addition to the general capital fund of the existing Ramsay Memorial Fellowship Trust in order to restore the number of British Ramsay Fellows to the original figure from which it had fallen owing to the decrease in the value of money. The appeal has been successful, and the Trustees have now issued a report (pp. 23; from University College, London, 1955). The report gives a list, with amounts, of all the subscribers: "The Centenary Appeal was directed chiefly to industry and industry has responded nobly". The division of the money is as follows: to University College, £75,000; to the Ramsay Memorial Fellowship Trust, £19,500; to the Glasgow Fellowship (for which a separate subsidiary appeal was made), £4,200. The new building for the Chemistry Department of University College was completed in August last year, and it enables the Department to take on about forty more honours students and about twenty-five more research workers. Whereas the Fellowship Trust has in recent years only been able to support one Fellow at a time, the increase in its funds will allow it to support two or, on occasion, three Fellows at a time. The report of the Trustees gives a brief résumé of the history of the Trust since it was first raised in 1916 after Ramsay's death, and lists the names of the 152 Ramsay Fellows to date, with brief notes on their careers.

Libraries in Colleges of Further Education in Britain

A report on "Libraries in Colleges of Further Education", prepared as Publication No. 20 by the Regional Advisory Committee for Librarianship of the London and Home Counties Regional Advisory Council for Higher Technological Education (pp. 12; 1954; 1s.), details recommended standards of accommodation, books and equipment for such libraries. It is contemplated that the libraries concerned should not only provide books and accommodation for both staff and students but should also encourage the use of printed matter among students and act as a clearing-house for both external and internal information. Not less than three rooms should be provided: a reading room and library of at least 2,700 sq. ft., and smaller rooms for a workroom and storage, respectively. The position of the library is also important: it should be quiet but central. Professional advice is essential on equipment, which should follow standard patterns as far as possible. Sound-absorbing material is recommended for floor-covering, and liberal provision made for technical equipment, including a microfilm reader. Adequate lighting should be maintained at shelf- and table-level, and provision for hanging up the outdoor clothes of readers is essential. Generally, a minimum initial stock of ten thousand items is essential for an institutional library to function efficiently, but the value of any library administered by a qualified librarian is enhanced enormously by the provision of bibliographical aids. The capital cost of such a stock at 1954 prices would be not less than £10,000, and the stock would require replacement over each decade so that £1,000 a year must be allowed for this purpose, apart from improvements and current purchases, estimated at £500 a year or more. Work at advanced- and university-levels demands greater provision, particularly for periodicals, which represent an increasing charge. Binding and provision of photographic copies of articles not available in the library are further charges to be allowed for in the budget, and it is recommended that the librarian should attend meetings of boards of studies and teachers' conferences and be kept informed of any projected developments in the curriculum.

British Information Services Overseas

In opening an adjournment debate in the House of Commons on British Information Services on April 19, Dr. Horace King, who has recently returned from a lecture tour, on behalf of the Foreign Office, in the United States, Canada and Iceland, paid a warm tribute to the work already being done. More British people are needed abroad if Britain is to make her full contribution to world peace. Particularly he urged the extension of the work of British Information Services in Canada, and he fully

endorsed the findings of the Drogheda Committee that the Overseas Information Services play an important and essential part in support of British foreign, Commonwealth and Colonial policies; and that the work should be done well, continuously and on an adequate scale. His experience showed that the work being done in the New World met the criteria of quality, continuity and reliability which the Drogheda Committee laid down as essential if Information Services are to exert influence. Dr. King's remarks on the untoward effect of the press campaign which resulted from the report of the Select Committee on Estimates on the Foreign Service was endorsed by other speakers in the debate, and his whole speech was welcomed by Lord John Hope, Joint Under-Secretary of State for Foreign Affairs, who replied for the Government. Lord John Hope said that the Government is fully conscious of the good work being done in the embassies and is doing all that it can to encourage the exchange of teachers and students. He believes that the maintenance of friendly relations between the English-speaking peoples of the world is the most important single factor in the maintenance of peace.

Biophysical and Biochemical Cytology

THE first number of a new journal, *Biophysical and Biochemical Cytology*, appeared in January, edited by Richard S. Bear, H. Stanley Bennett, Albert L. Lehninger, George E. Palade, Keith R. Porter, Francis O. Schmitt, Franz Schrader and Arnold M. Seligman, and published by the Rockefeller Institute for Medical Research, Baltimore, Md. (published bimonthly, single issues 1.50 dollars, annual subscription 7.50 dollars). From the composition of the editorial board it appears probable that the new journal is intended primarily for the publication of researches carried out in the United States. The intention is "to provide a common medium for the publication of morphological, biophysical and biochemical investigations on cells, their components and their products. It will give special attention to reports on cellular organization at the colloidal and molecular levels and to studies integrating cytological information derived from various technical approaches". The provision of a new journal for publishing work on morphological studies and biophysical studies of cells, with particular emphasis on electron microscopy, will be a valuable service. It is to be hoped, however, that the more biochemical and cytochemical investigations will not be published in this journal, but in the journals which have hitherto made provision for work that is primarily cytochemical or biochemical in nature. The large number of journals that exist already gives rise to some difficulty in keeping in touch with some fields of research, and the primary purpose of journals for the publication of original research should be to bring together material which has a common technical basis.

Greenwich Observations during 1953–54

Two volumes, for 1953 and 1954 respectively, of the "Observations in Astronomy, Magnetism and Meteorology made at the Royal Observatory, Greenwich" have recently been published (pp. 405+12 plates, 90*s*. net, 1953; pp. 270+7 plates, 70*s*. net, 1954. London: H.M.S.O.). Corresponding issues for 1940, 1941, 1942, 1943 and 1944 have not yet been published, but those for 1940 and 1941 are expected from the printers very soon. The two volumes under consideration follow the usual plan: section *A*, meridian astronomy, includes work on the transit circle, time service and variation of latitude. Section *B*, equatorial observations, does not appear in the 1954 issue because no equatorial observations were made in that year. Section *C*, photoheliographic observations taken at Greenwich, the Cape and Kodaikanal, includes the daily measures of positions and areas of sunspots and faculæ, general catalogue of groups of sunspots, divided into recurrent groups and non-recurrent groups, total areas of sunspots and faculæ for each day, mean areas of sunspots and faculæ for each rotation and for the year, mean heliographic latitude of spots for each rotation and for the year, and observations of solar flocculi made with the spectrohelioscope. Section *D*, magnetic and meteorological observations, is followed by the report of the Astronomer Royal to the Board of Visitors for each year.

Mydriatic Alkaloids in Excised Root Cultures

T. M. STIENSTRA has pointed out that the literature contains few references to the formation of alkaloids in aseptic root cultures, and that the media used have not been entirely synthetic in composition. She now reports the formation of mydriatic alkaloids in excised root cultures of *Datura stramonium* grown in a completely synthetic medium (*Proc. Koninkl. Nederlandse Akad. Wetens.*, **57**, No. 5, Ser. C, 584; 1954). Procedures for obtaining rapidly growing sterile root cultures from seedlings, the composition of the synthetic medium, and methods for extracting and identifying the alkaloids are described. Hyoscyamine appears to be the substance mainly present in the roots. The author reports that, in roots cultured for seventy-seven days, twenty-four times the amount of the alkaloid initially present was synthesized. In an addendum it is noted that the formation of alkaloids in excised root cultures of *Datura* and *Hyoscyamus* had already been described by O. F. Uffelie (*Pharm. Tijdscr. v. België*, **28**, 65; 1951).

Joint Metallurgical Societies Meeting in Europe

THE leading metallurgical societies of Belgium, France, Germany, Great Britain and Sweden, together with representatives of the American Institute of Mining and Metallurgical Engineers and the American Society of Metals, will be meeting in Europe during June 1–18 to discuss technical and scientific developments in metallurgy and to see something of the various and diverse metallurgical industries in Europe. The proceedings will cover the following topics: iron-making (including coke and ore preparation); steel-making; mechanical working and heat treatment, both ferrous and non-ferrous (including hot and cold rolling, forging, wire-drawing and continuous casting, but not the foundry industry); refining and fabrication of non-ferrous metals; heat treatment; surface treatment (including finishing and coating); metallurgical education and training in industry; and research. The meetings will commence in Great Britain during June 1–7, when the Iron and Steel Institute and the Institute of Metals will be the joint hosts. The discussions will be held in London at Church House, Westminster, and visits will be made to a number of places of technical interest in or near London. In addition, five special tours, each lasting several days, have been arranged for a limited number of members to see one of the following metallurgical areas in Britain: South Wales, Birmingham, Sheffield and

Scunthorpe, Durham and Yorkshire, and Scotland. After the sessions in Great Britain, meetings will be held on the Continent of Europe as follows: June 9–12, Düsseldorf; June 13, Liège; and June 14–18, France (Paris and tours of northern, eastern, central and south-eastern France). Following these, tours are being arranged to other European countries, including Austria, Italy, Spain and Switzerland. Further information can be obtained from the Secretaries of the Iron and Steel Institute or the Institute of Metals, both of which organizations are at 4 Grosvenor Gardens, London, S.W.1.

Royal Institution: Officers

THE following have been elected officers of the Royal Institution: *President*, Lord Brabazon of Tara; *Treasurer*, Dr. L. H. Lampitt; *Secretary*, Mr. S. Robson; *Managers*, Mr. L. V. Chilton, Dr. A. Clow, Mr. E. R. Davies, Sir Alfred Egerton, Prof. A. V. Hill, Mr. L. B. W. Jolley, Dr. L. A. Jordan, Dr. A. R. Kagan, Dr. H. Lowery, Dr. A. C. G. Menzies, Mr. J. A. Oriel, Mr. W. E. Schall, Dr. J. H. Schulman, Mr. P. H. Schwarzschild and Dr. S. Whitehead; *Visitors*, Mr. W. W. Abson, Lieut.-Colonel S. J. M. Auld, Mr. W. Burrells, Major W. H. Cadman, Mr. A. D. R. Caroe, Mr. R. C. Chirnside, Dr. F. H. Cotton, Mr. W. A. Dickie, Prof. James Greig, Prof. Kathleen Lonsdale, Dr. R. Scott Russell, Mr. W. R. Stevens, Dr. Norman Stuart, Dr. D. T. A. Townend and Prof. H. E. Watson.

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: R. G. Heath (deputy director, to be director of agriculture, Federation of Malaya); D. H. Laycock (agricultural officer, Nyasaland), tea research officer, Nyasaland; J. D. Kelsall (fisheries officer, East Africa High Commission), chief fisheries officer, East Africa High Commission; J. W. Pallister (senior geologist, Uganda), assistant director of geological surveys, Uganda; R. C. Anslow, senior agricultural officer (grassland and fodder), Mauritius; W. M. Barker, agricultural officer, Nyasaland; J. S. Boston, assistant surveyor of antiquities, Nigeria; C. G. Merton, assistant conservator of forests, Sarawak; A. H. Tothill, assistant conservator of forests, Uganda; J. R. Currie, pathologist, Sierra Leone; T. A. Rohan, senior specialist (organic chemist), West African Cocoa Research Institute, Gold Coast; T. M. Hurley, veterinary officer, Northern Region, Nigeria; D. G. Nelson, veterinary officer, Gold Coast.

Announcements

WE regret to announce the death of Dr. E. Morland, editor during 1937–44 of the *Lancet*, on April 26, aged eighty.

DR. W. HUME-ROTHERY, lecturer in metallurgical chemistry in the University of Oxford, has been elected to the George Kelley readership of metallurgy in the University as from October 1.

DR. WILLIAM REID, chairman of the Scottish Division of the National Coal Board, has been elected president of the Institution of Mining Engineers for the year 1956–57 and will succeed Major Noel Webster at the sixty-second annual general meeting to be held in London early next year. Dr. Reid, who is a graduate of the University of Edinburgh, was born in 1906 and has a family connexion with the coal-mining industry in Scotland covering a period of more than a hundred years, his father being the distinguished mining engineer, Sir Charles Reid. He was appointed production member of the National Coal Board early this year.

THE Mathematics and Natural Sciences Faculty of the Technical University of Dresden has conferred an honorary doctorate on Prof. J. Heyrovský, of Prague, for contributions to electrochemistry by his work on polarography.

THE National Physical Laboratory, Teddington, is holding an open day on May 20. Admission is by ticket only and a limited number of invitations for the afternoon period 1.30–5.30 p.m. are available on application to the Director.

THE laboratories of the British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1, will be open to members of the Association and others during May 24–27 to mark the twenty-fifth anniversary of the establishment of the Association's laboratories in London.

THE Feeney chair of metallurgy in the University of Birmingham, vacant since the death in 1953 of Prof. D. Hanson, has been renamed the Feeney chair of physical metallurgy. Prof. G. V. Raynor, professor of physical metallurgy in the University (see *Nature*, **164**, 819; 1949), has been appointed to the Feeney chair.

THE Textile Institute has awarded a research studentship to B. S. Hsu, of the College of Technology, Manchester, where he is at present engaged on research on the relaxation of tensile stress in synthetic fibres under different constant strains and at various humidities and temperatures. Mr. Hsu, who was born in Shanghai, came to England in 1951 and took a full-time degree course in textile technology at the Manchester College of Technology, graduating with first-class honours last year.

THE Chemical Society will be holding a symposium on the Friedel–Crafts reaction in the Department of Chemistry, University of Leeds, on May 18. The symposium is being specially arranged on the occasion of the visit of Prof. H. C. Brown, of Purdue University, to Great Britain. Further information can be obtained from the General Secretary of the Society at Burlington House, Piccadilly, London, W.1.

THE Department of Chemistry of the Israel Institute of Technology, Haifa, is holding a symposium on the chemistry of natural products during June 28–29. Of the ten scientific workers reading papers, three will be from the United States and two from Great Britain. Further information can be obtained from the professor of chemistry at the Institute, Prof. David Ginsburg.

MR. D. RIDER, 19 Portland Place, London, W.1, states that he has been asked by the British Lamp-blown Scientific Glassware Manufacturers' Association to prepare a history of the British lamp-blown scientific glassware industry, concentrating in the main on the past two hundred years. The industry is, of course, concerned with the manufacture of scientific apparatus by hand, but also covers the production of tubular glass containers and other glassware by machinery. He would be glad to receive information about the history of scientific glassware from the companies within the industry.

ERRATUM. In the communication "Reactions between Quinones and Proteins" in *Nature* of April 30, p. 771, absorption maxima should be in "mμ", not "μ" as printed.

MATHEMATICAL ASSOCIATION

ANNUAL MEETING

THE annual meeting of the Mathematical Association for 1955 was held during April 13–16 at University College, Leicester, under the presidency of Prof. W. V. D. Hodge, Lowndean professor of astronomy and geometry in the University of Cambridge. On April 14 the presidential address, entitled "Changing Views of Geometry", was delivered. Prof. Hodge referred to the late nineteenth-century view, expressed by Klein in the famous Erlanger Program, that geometry deals with properties invariant under a group of transformations, and pointed out that this formulation had been to some extent misleading and is by now certainly inadequate. By the 1920's, geometry had become separated from the main stream of mathematics and was indeed suffering from a temporary exhaustion, though the development of birational geometry had shown the need to break the tyranny of the Erlanger Program. Prof. Hodge suggested that a geometry to-day might be described as the study of a space with a structure; he analysed the meaning to be attached to the words 'space' and 'structure', and showed that this description would help to re-integrate geometry into the main fabric of mathematics. Whether the geometer works directly from axioms or through an algebraic representation is, Prof. Hodge thought, largely a matter of taste; but he declared that what is required from young people entering a university with the intention of studying geometry is not any great ingenuity in solving tricky problems, but a thorough understanding of what geometry is about, and a sound knowledge of the elementary techniques of the subject.

Mr. A. Prag (Westminster School) spoke to the meeting on "Mathematical Literature", mentioning some of the key developments to be found in the classical works of the early mathematicians, and illustrating these by reference to some of the bibliophile's treasures to be found in the Association's own Library. This is housed at University College, Leicester, and though chiefly used as a postal lending library, it was on show to members during the meetings. On April 15, the first item was a paper by Prof. R. L. Goodstein (University College, Leicester) on "The Definition of Number". He showed the logical difficulties which arise in attempting to give a definition of whole numbers, the Frege–Russell class theory leading to antinomies while the Peano axiomatic method fails to specify a unique set. The extension of the number concept to positive and negative integers, fractions and complex numbers was also critically described. Following this, the Association proceeded to a discussion of its recently issued report on "The Teaching of Mathematics in Technical Colleges"; those opening the discussion were Mr. F. W. Kellaway (North Hertfordshire Technical College), Dr. H. Frazer (Gateway School, Leicester) and Mr. A. J. L. Avery (Derby Technical College). The details of the report were commended; but members showed some anxiety about the general relations between education in the secondary modern schools and in the technical colleges, and with the alleged excessive wastage during the course of the normal five-year curriculum of technical education. The Association was glad to hear that an increasing number of technical students find their way to a university degree.

The first item in the afternoon session was a discussion of "The Disadvantages of a Mathematical Education", led by Mr. W. O. Storer (Department of Education, University of Birmingham); Mr. Storer thought that the logical training supposedly given by mathematics might be arid, and that mathematical insistence on accuracy might lead to intellectual arrogance. Some members were reluctant to accept these inferences. In the next paper, "High-Speed Computers and their Application to Lens Design", Mr. W. M. Wreathall (Taylor, Taylor and Hobson, Ltd., Leicester) outlined the methods of obtaining the optical formulæ required, and showed that the very laborious calculations needed in applying these formulæ could now be handled readily by modern high-speed computers. After tea, Dr. Paul White (University of Reading) asked "What is the Matter with Negative Mass?". Dr. White asserted that the young research student must be prepared to question and to analyse fundamental assumptions, and illustrated the attitude of mind required by suggesting that the consequences of supposing that a particle might have negative mass could be examined. Some of these consequences are surprising, and Dr. White concluded by exhibiting, not entirely seriously, plausible reasons for believing that the original state of the universe consisted of equal quantities of particles of positive and negative mass, but that fluctuations of distribution had ultimately driven the negative masses to great distances. The final paper, on April 16, "The Applications of Statistics to Industry", by Mr. M. J. Moroney (chief statistician, Unilever, Ltd.), assumed that members were familiar with the mathematical elements of statistics and discussed, with much wit and force, the means whereby works managers could be made to understand that many of their production and distribution problems are amenable to treatment by statistical methods which can be explained in simple terms.

The president of the Association for the year 1955–56 is Mr. G. L. Parsons, of the Merchant Taylors' School, Sandy Lodge.

HYDRAULIC CONVEYING OF SOLIDS

THE tendency of process industries to-day to change from batch-wise to continuous operation is reflected in a renewed interest in pneumatic and hydraulic transport and a wider application of these systems to the conveyance of materials of all kinds. In both cases, the underlying principle is the application of forces to the solid by a conveying fluid travelling through a pipe-line in turbulent flow, so that the solid is carried forward in suspension at approximately the same velocity as the fluid in the case of hydraulic conveying, and at a rather lower velocity in pneumatic conveying. The mechanism is complicated; but the parameters involved can be identified and investigated in comparatively simple plant.

Although hydraulic conveying has long been used for handling a variety of materials, including gravels,

mine tailings, china clay and coal, no theoretical treatment has been proposed upon which the size of an installation and the power consumption for a specific duty can safely be based. The design engineer is still forced to rely on such published data as are available, relating to a restricted range of materials and operating conditions.

During recent years, however, systematic research has been in progress, notably in Britain and in France, in an effort towards obtaining a better understanding of the mechanisms involved. The results of some of this work were described in three papers read before the Institution of Chemical Engineers on March 15.

The first paper, by D. M. Newitt, J. F. Richardson, M. Abbott and R. B. Turtle (Department of Chemical Engineering of the Imperial College of Science and Technology, London), gave a brief summary of previous work and included an account of an experimental investigation into the behaviour of a wide variety of materials conveyed in a pipe of 1 in. diameter in a circulating system. Data were given for suspensions of graded solids from 0·0008 to 0·15 in. in diameter, specific gravities in the range 1·18–4·6, and volumetric concentrations up to 33 per cent.

It was shown that, over the range of velocities attainable in the system, five distinct modes of flow can occur, varying from fully suspended flow at high velocities to flow with a bed of solid moving at a uniform rate in the lower part of the tube, at low velocities. When pressure drop is plotted against velocity for a given concentration of suspended solid, a curve is obtained showing a minimum pressure drop at some critical value of velocity not far removed from that at which deposition occurs with subsequent choking. Some interesting observations were also made on the flow characteristics of suspensions of solids of mixed sizes. It appears that the transport of a coarse material may be facilitated by the admixture of a small proportion of fines, resulting in an increase in the overall carrying capacity of the system for a given pressure drop.

The results obtained with a 1-in. pipe can be correlated with reasonable accuracy by an equation based on simple theory. It is interesting to note that the equations are similar to the empirical relationships obtained by Durant, the only important difference being in the index of the pipe diameter term.

The second paper, by R. A. Smith, related to work carried out at the Billingham Division of Imperial Chemical Industries, Ltd., on the pumping of suspensions of sand in water through horizontal pipes of 2 and 3 in. in diameter. Measurements were made with closely sized and with mixed materials, and it was found that the pressure drop is always greater than that which would be obtained with a true fluid of the same density and viscosity as the suspension. With the non-uniform materials, the experimental results can be correlated with those for particles of a single size, by using a mean particle size, giving the same surface/volume ratio as for the mixture. The selection of a suitable pump, which will handle the suspension without serious risk of blocking and, at the same time, will have a reasonably high efficiency, is an important feature in the design of an installation. The pump used in the present work was of the centrifugal type, and was found to operate at an almost constant efficiency for volumetric concentrations up to 24 per cent.

In the third paper, by K. E. Spells (formerly with Imperial Chemical Industries, Ltd., Widnes, and now at the R.A.F. Institute of Aviation Medicine, Farnborough, Hants), the experimental results of a number of workers were discussed, and a dimensional analysis of the variables of the process was attempted. It was shown that, in all cases, there is a minimum velocity at which transport can safely be effected, corresponding to the condition where particles start to fall out of suspension. As the velocity is increased, the pressure gradient tends towards that obtained with a true fluid of the same density and viscosity as the homogeneous suspension. Although this condition is approached asymptotically, Mr. Spells claims that it is generally possible to assess fairly accurately the 'standard' velocity at which the two pressure gradients coincide. The correlations are obtained with both vertical and horizontal pipe-lines, but are limited to conditions where the particle size is small compared with the pipe diameter.

D. M. Newitt
J. F. Richardson

EMBRYOLOGY OF MAMMALS

In 1914, "Contributions to Embryology" was started to cater for those studies of the Carnegie Institution's Department of Embryology as were likely to prove too long and too lavishly illustrated for ordinary technical journals. Few ventures in scientific publication can ever have been better justified. The "Contributions" have become—what they promised to be at the beginning—the major single source of our information about mammalian embryonic development. The earlier volumes were devoted chiefly to descriptions of human embryos, and to accounts of placentation and the development of the systems of the body. Franklin P. Mall, who initiated the publication, and who was the Department's first director, was also keenly interested in the study of the mammalian reproductive cycle. The "Contributions" have, therefore, also had a profound influence on the development of experimental endocrinology. Vol. 2, published in 1915, carried an article by G. W. Corner, the present director, on the corpus luteum of gestation. Corner's analysis of the phases of the menstrual cycle in the rhesus monkey appeared in 1923, and in 1927 the "Contributions" published the first major experimental study, by the late Edgar Allen, of the hormonal basis of the primate reproductive cycle. The study of primate reproduction was taken an important step forward in 1933 with a description, by Lewis and Hartman, of the segmenting human ovum. Then, in 1941, side-by-side in the same volume, there appeared an account by Hartman and Corner of the first segmentation division of the fertilized egg of a monkey, and a description, by Hertig and Rock, of segmenting human ova no older than eleven to twelve days.

Vol. 35, which has recently been published*, goes yet further. In addition to a series of distinguished monographs that deal with regional embryological studies (among which is one by Bartelmez and Blount on the formation of the neural crest in man), as well as several of a more experimental kind (including one by Wells and van Wagenen on the induction of pseudo-hermaphroditism in monkeys), the volume provides a further description, by Corner and Bartelmez, of early embryos of the rhesus

* Contributions to Embryology, 35. Publication No. 603, Nos. 231–241 (1954). Pp. 237 + 54 plates + 57 figs. 12 dollars paper bound, 13 dollars cloth.

monkey; and an account by Hertig, Rock, Adams and Mulligan of four normal and four abnormal human ova ranging in age from the fifth day of development to as little as one day after fertilization. These showed, *inter alia*, that the human blastocyst is prepared for implantation slightly more rapidly than the monkey egg.

It is odd to think that until relatively recently the number of early human embryos that have been studied was so few that almost each had a name. The enormous increase in the amount of material that has become available for study is a direct consequence of the interest in the whole of this problem that has been generated by the Carnegie Department of Embryology. It is also a direct outcome of the researches on reproduction in which the Department has played so big a part, and which have made it possible to estimate when ripe follicles will be present in the ovaries, and when ovulation is likely to occur. Armed with this knowledge, it is possible to time certain types of operation that have to be carried out so as to increase the chances of recovering, for scientific study, the human egg in its first stages of development. The latest chapter of the story is not, however, told in Vol. 35 of the "Contributions". The December 1954 issue of the *Transactions of the New York Academy of Sciences*, and the February 1955 number of the *American Journal of Obstetrics and Gynecology*, include articles by Landon B. Shettles describing the *in vitro* fertilization of the human ovum and its transformation into an eight-cell morula. This is a great technical achievement, and it opens up the possibility of exploring still further some of the most basic problems of human development.

S. Zuckerman

ELECTRICAL PROPERTIES OF WOOD

THE electrical properties of wood are of importance in high-frequency heating processes, in the use of wood as an insulator, and in the determination of moisture content by electrical means. Whereas the direct-current behaviour of wood can be specified solely by the electrical conductivity, the alternating-current behaviour requires two quantities—the relative permittivity (or dielectric constant) k, and the loss tangent tan δ—for its specification. In order to assess the effect of frequency, grain direction and moisture content on the dielectric properties of wood, R. F. S. Hearmon and J. N. Burcham have recently measured k and tan δ for twelve different species of wood in the three grain directions, at moisture contents up to 18 per cent and more, the frequency range being 2 kc./s.–60 Mc./s.*. The specimens were in the form of disks, approximately 5 cm. in diameter and 0·6 cm. thick, and tin-foil electrodes were attached to the flat faces with a thin film of 'Vaseline'.

The results for the two species, sitka spruce and oak, representing medium–light and medium–heavy timbers respectively, are presented and discussed in some detail. The permittivities change uniformly with moisture content and frequency, being closely related to the density, and a method is suggested by which the permittivities of any timber may be predicted approximately in terms of the density, moisture content and frequency. The inter-relationship between loss tangent and these three quantities is, however, highly complex, and it is not possible to predict values of tan δ with any accuracy. A few measurements were made, in addition, on oak of moisture content 75 per cent and on wych elm of moisture content 70 per cent, and although k and tan δ varied considerably with frequency, the electrical conductivity did not change greatly over the frequency range 1–100 kc./s. It is concluded that for low moisture contents the results are in accord with the qualitative description of the dielectric behaviour of wood, which can be given in terms of the dipolar mechanism of electrical conduction, but that for high moisture contents the effect of ionic conductivity becomes of greater importance and must be taken into account.

* Forest Products Research Special Report No. 8: The Dielectric Properties of Wood. By R. F. S. Hearmon and J. N. Burcham. Pp. iv+20. (London: H.M.S.O., 1954.) 1*s.* 6*d.* net.

CACAO RESEARCH

THE staff of the Cacao Research Scheme at the Imperial College of Tropical Agriculture, Trinidad, comprises plant breeders, physiologists, soil chemists, a biochemist, a mycologist, an entomologist and estate personnel. The aim of the research programme is to improve the yield and quality of cacao beans, that is, it is essentially of an applied character, such fundamental research as may be undertaken being in direct relation to practical needs. In the Report for 1953 now published (obtainable from Trinidad or from the London Office, 40 Norfolk Street, W.C.2; November 1954; 10*s.* 6*d.*) an account is given of research completed, research in progress and research contemplated.

An interesting account is given of the 1952–53 collecting expedition to Colombia. This includes full notes on the different forms of cacao (*Theobroma cacao*) observed, together with some thirteen other species which were collected, and ten species of the related genus *Herrania*. This venture also yielded valuable information on the insects, and their parasites and predators, associated with these plants, and on the incidence of the witches' broom and *Monilia* fungal diseases. Many of the new materials have now been established in Trinidad. A more general result of the expedition has been to support the view that the centre of origin of cacao probably lies near the Colombian–Equadorian frontier on the eastern flanks of the Andes.

Experiments on the effects of shade and fertilizer applications have shown that, as light intensity increases, the trees become more vigorous but, at 75 and 100 per cent light, growth is dependent on fertilizer treatment: in the absence of additional nitrogen the plants are stunted, but with nitrogen they are very vigorous, yielding considerable lateral branching and a closed canopy. The mean yield increases with increasing light intensity up to 50 per cent light; thereafter it decreases progressively. This trend is, however, reversed by nitrogen additions, maximum yields being recorded at 75 per cent light. Light is especially important in determining the duration of the cropping period. At low light intensities there is a steady production of pods but no peak harvest, whereas with 50 per cent light, or more, all pods mature in a peak period. Fertilizer applications both advance the onset of harvesting and yield a distinctive peak as compared with the controls.

A new, effective and relatively cheap technique for the rooting of cacao cuttings has now been suggested. Baskets of soil, with a central core of composted

sawdust, are prepared and the cutting inserted in the compost, one per basket. The cuttings are then rooted in a shaded glasshouse with controlled humidity at 100 per cent. It is stated that one unit could supply 30,000 plants ready for field planting.

Techniques for the complete study of the contents of a single pod have been taken a stage further by the use of an improved microfermentary. Improvements have also been effected in the solar fermentary, which is of a capacity intermediate between the normal fermentation box (or sweatbox) and the microfermentary.

Other papers in this report are concerned with such topics as physical measurements of soil, the effect of shade and of mulching on soil temperature, nitrogen partition in the normal cacao leaf (as a contribution to an understanding of the rate of development of some pest populations), the susceptibility of various selections to witches' broom disease, spraying against this disease, and various entomological and cultural studies. Researches in progress and those contemplated are also briefly annotated.

MICRO-FOSSILS IN EARLY FLORAS

ATTENTION has been directed to the important bearing of certain micro-fossils on our knowledge of the nature and composition of Pre-Carboniferous floras in Canada by N. W. Radforth and D. C. McGregor (*Canadian J. Bot.*, **32**, 5, 601; 1954).

It has now been ascertained that, in Canada, rocks of Devonian age are associated with the occurrence of oil and gas. In some of these oil-yielding areas, which present serious difficulties to the stratigrapher because of the presence of 'unfossiliferous' sediments, that is, barrenness of plant remains as macro-fossils, it appears that the investigation of the micro-fossils is likely to afford a tool of practical value, and to yield information of very great interest to the palæobotanist; for the Devonian period has long been held to be one of critical importance in the evolution and development of the flora of the land.

Fifty-six recently discovered spores and spore-like micro-fossils from Canadian non-coaly deposits of Middle and Upper Devonian age have now been described and classified by these investigators. The manner of occurrence of these fossils suggests that they may probably be useful in ascertaining biostratigraphical entities and in the further investigation of oil-bearing rocks.

In relation to the evolution of plants, these micro-fossils afford evidence of a more complex and more highly evolved Devonian flora than has been apparent from the macro-fossil record. Furthermore, preliminary investigations have disclosed spores of comparable abundance and of only slightly less complexity in rocks of Lower Devonian and Silurian age.

On the preliminary evidence now presented, that is, of the existence of large and diversified spore populations in different strata, even in those of Lower Devonian and Silurian age, it appears that the land flora of the Devonian period was both varied and extensive, this being contrary to the commonly held view. The discovery of relatively complex micro-fossils in Silurian rocks containing *Monograptus* is important from the botanical point of view: it indicates that the complexity of form and structure which are normally associated with the vascular plants probably came into existence very much earlier than has usually been assumed, that is, on the evidence derived from the study of such stems, leaves and sporangia as have come to light. Special interest is attached to a Devonian micro-fossil which in appearance resembles angiosperm pollen, though, as the authors are careful to point out, any conclusion about it at this stage would have to be viewed with the greatest caution.

RESPIRATORY PIGMENTS OF *RHODOSPIRILLUM RUBRUM*

By Dr. BRITTON CHANCE and Dr. LUCILE SMITH

Johnson Foundation, University of Pennsylvania

SENSITIVE spectroscopic methods for recording differences of optical density between aerobic and anaerobic suspensions of many types of bacteria have made possible accurate identification of the patterns of their cytochromes, flavoproteins and pyridine nucleotide enzyme systems[1]. We report here a study of the respiratory pigments of *Rhodospirillum rubrum*, the bacterium in which Duysens[2] and Vernon and Kamen[3] have concluded that a cytochrome with an absorption spectrum similar to that of cytochrome *c* is oxidized in a photochemical reaction.

Spectroscopic changes occurring when the aerobic bacterial suspension became anaerobic were recorded at a series of different wave-lengths from 650 to 390 mμ (as in Fig. 1*A*) by means of a double-beam apparatus[4]. In each case the difference between the given wave-length and some reference wave-length was recorded; this eliminated any interference which might have resulted from changes in the light-scattering properties of the bacteria. In some experiments the difference in optical density between two forms of the pigments in two different cuvettes was recorded by means of a split-beam instrument[5], as illustrated in Fig. 1, *B* and *C*. Photochemical effects upon the spectrum (Figs. 2 and 3) were recorded with the same apparatus that was developed for measuring the photodissociation difference spectra of the carbon monoxide compounds of cytochrome oxidases[6]. Here infra-red illumination was obtained from a tungsten lamp through two thicknesses of Wratten 88*A* filter plus Corning 2424. Neutral filters of density between 0·5 and 2·0 were also added until the observed effect of illumination of aerobic cells was very small, similar to that illustrated in Fig. 3*A*. The bacteria were obtained through the kindness of Dr. M. D. Kamen and were grown as described by him[7], except that tap water and twice the concentration of yeast extract and biotin were used. For measurements in the Soret region of the spectrum, cells obtained after two to three days growth were used directly; these had an optical density at 800 mμ of about 1·0 cm.$^{-1}$. Denser suspensions for use in the visible region of the spectrum were obtained by centrifuging the cells, then suspending them in the supernatant fluid.

Dark Reactions of the Pigments

The difference spectra plotted in Fig. 1*A* and Fig. 2*A*, curves *a* (difference in optical density

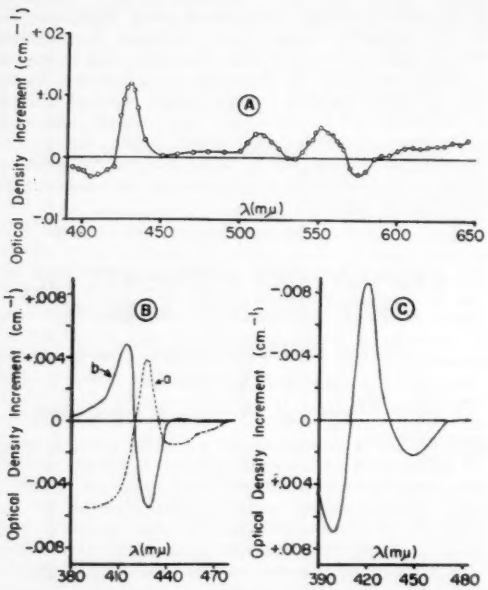

Fig. 1. (*A*) Differences of optical density occurring when an aerobic suspension of *Rhodospirillum rubrum* becomes anaerobic. Changes observed at wave-lengths indicated with the double-beam apparatus; reference wave-length, 450 mμ

(*B*) Shift of the Soret band caused by adding carbon monoxide to anaerobic bacteria; measurements made with the split-beam instrument. *a*, aerobic bacteria in the reference cuvette and anaerobic cells in the other cuvette; *b*, anaerobic cells in the reference cuvette and anaerobic cells plus carbon monoxide in the other cuvette (pure carbon monoxide for 30 sec.)

(*C*) Effect of phenylmercuric acetate (0·1 m*M*) upon the Soret band of aerobic bacteria, recorded in the split-beam instrument. Aerobic cells in the reference cuvette and aerobic cells plus the inhibitor in the other cuvette. Since the absorption bands of reduced cytochrome *c* disappear, decrease in optical density is plotted upward (Exp. 397)

between the reduced and steady-state oxidized pigments) give an insight into the respiratory pigments present in the organisms. The peak in the visible region of the spectrum at 550 mμ corresponds to the cytochrome c_2 isolated from the bacteria by Vernon[8]. The shoulder at about 563 mμ indicates that a cytochrome of type *b* is also present. Although there is sometimes observed a small deflexion in the difference spectrum around 590 mμ, there is no positive identification of cytochromes *a*, a_1 or a_3. The main absorption band in the Soret region of the spectrum is at 428 mμ, which is characteristic of the cytochromes of type *b*, and is mainly due to a pigment which reacts with carbon monoxide, as is shown by the considerable disappearance of the band at 428 mμ when carbon monoxide is added to the reduced form of the pigments (Fig. 1*B*). The difference spectrum of the carbon monoxide compound has a peak at 415 mμ and is very similar to that of a terminal respiratory enzyme found in several kinds of micro-organisms[9]. This carbon monoxide-binding pigment, which may also be the terminal respiratory enzyme of these bacteria, could be identical with a pigment isolated from *Rhodospirillum rubrum* by Vernon and Kamen[10].

The reduced minus steady-state oxidized difference spectrum of *Rhodospirillum rubrum* differs from those of numerous other bacteria in the relationship of the heights of peaks[11]; the peak around 515 mμ is large and that at 428 mμ is small in relation to the peaks at 550–563 mμ. This may mean that changes of optical density due to pigments other than the cytochromes are apparent in the visible region of the spectrum. Also we have not yet found evidence of spectral changes due to flavoprotein or pyridine nucleotides in any of the difference spectra recorded.

If phenylmercuric acetate is added to the aerobic bacteria (to a final concentration of 0·1 m*M*), the respiration of the bacteria is inhibited and the strong band at about 420 mμ in the absorption spectrum (Fig. 1*C*) and a smaller one at 550 mμ disappear. This must be attributed to the oxidation of cytochrome *c*, which is apparently largely reduced in the aerobic state. From a comparison of spectra such as that in Fig. 1*C* with Fig. 1*A*, it was calculated that the cytochrome *c* was about 60–70 per cent reduced in the aerobic steady-state.

Reactions of Pigments on Illumination

Fig. 3*A* is a recording by the double-beam apparatus of the optical density changes at 430 mμ minus 440 mμ when the bacteria were illuminated in both the aerobic and the anaerobic states; Fig. 2*A* shows these changes of optical density at different wavelengths in the Soret and visible regions of the spectrum. With the light intensity used, illumination of the aerobic organisms produced only small effects. Illumination of the anaerobic organisms resulted in changes of optical density similar to those observed

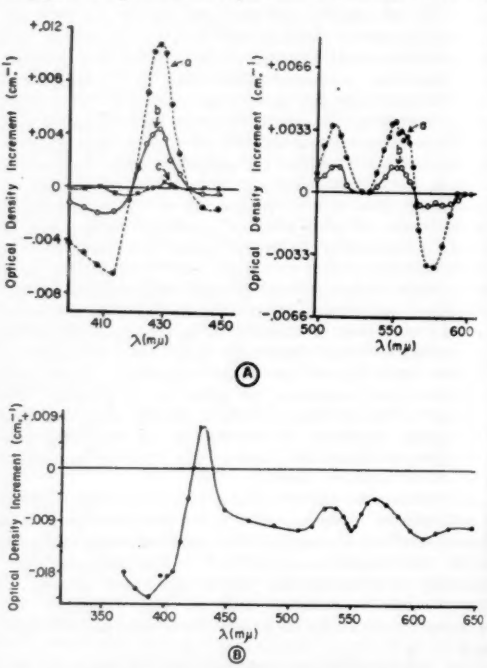

Fig. 2. (*A*) Comparison of the spectroscopic effects of oxygen and infra-red illumination, recorded in the double-beam instrument at the wave-lengths indicated. *a*, Absorption bands of respiratory pigments that appear when the bacteria become anaerobic; *b*, those appearing upon cessation of infra-red illumination; *c*, changes of optical density on cessation of illumination of the aerobic bacteria. The spectra in the visible and Soret regions were measured with different samples of bacteria

(*B*) Absorption bands appearing upon infra-red illumination of aerobic bacteria treated with phenylmercuric acetate (final concentration = 0·1 m*M*), recorded with the double-beam instrument. Reference wave-length 440 mμ (Exp. 399)

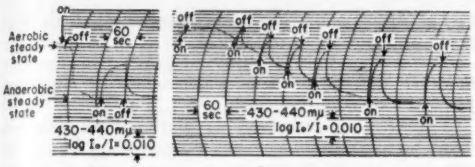

Fig. 3. Recording from the double-beam spectrophotometer: (*A*), illustrating the kinetics of the reduction of the cytochromes as the suspension becomes anaerobic, as well as the effects of illumination of both aerobic and anaerobic cells; (*B*), showing increase in optical density changes on illumination with increasing reduction of cytochrome. Carbon monoxide was added to prolong time of reduction of the cytochromes (Exp. 398)

on aeration, as shown in curves *a* and *b* of Fig. 2*A*; but the change following illumination was always smaller, usually reaching a value of 50–80 per cent of that observed on aeration. The spectrum of the changes in optical density following illumination is similar to that reported by Duysens[2], but we have been able to obtain more detail in the visible region. Our results indicate that the whole cytochrome system of the bacteria, rather than the cytochrome c_2 only, becomes partially oxidized on illumination. The effect does not seem to result from the production of oxygen, since van Neil could find no evidence for production of oxygen on illumination of the organisms[13], and we observed the same changes of optical density when the bacteria were illuminated in the presence of 1 m*M* sodium hydrosulphite. The anaerobic light effect clearly increases in proportion to the extent of reduction of the cytochromes, as shown in Fig. 3*B*; but inhibitors of the oxidation of the cytochromes, such as 3 m*M* cyanide or 1 m*M* carbon monoxide, do not inhibit the changes in optical density following illumination of the anaerobic cells.

The results do not agree with the suggestion of Vernon and Kamen[3] of a photo-oxidation of cytochrome c_2, for we find that cytochrome c_2 remains largely reduced when aerobic cells are illuminated, and the illumination of the anaerobic cells does not produce as large an effect as addition of oxygen. The photo-oxidation investigated by Vernon and Kamen resulted from high light intensities and was found to require oxygen; thus it may not be related to the changes following low-intensity illumination of the anaerobic cells.

If the aerobic bacteria treated with 0·1 m*M* phenylmercuric acetate are illuminated with the same low infra-red intensities as were used to obtain the observations of Fig. 2*A*, an absorption band rapidly appears that has a peak at 432 mμ in the Soret region (Fig. 2*B*). This peak corresponds very closely to that of the reduced form of the cytochrome that combines with carbon monoxide (Fig. 1*B*). The peaks in the visible region of the spectrum are not positively identified and may, in part, be due to an additional pigment. (This difference spectrum has a certain resemblance to that of an oxy-hæmoglobin compound or a complex II of peroxidase. But neither oxygen nor peroxide causes this spectrum to appear; illumination of the aerobic mercury-inhibited cells is required. It is possible that an oxidation of unidentified material by (OH) also occurs simultaneously with the photoreduction reaction.) The reduction of the pigment on illumination is suggestive of the reduction of ferrimyoglobin on illumination of chloroplasts[18].

The kinetics of the changes in optical density following illumination may be diphasic, depending upon the wave-lengths employed, which confirms that illumination affects a series of cytochromes, not just a single one. During both anaerobic illumination and aerobic illumination in the presence of phenylmercuric acetate, the absorption band found to respond most rapidly to illumination is that at about 430 mμ.

The hypothetical scheme of Fig. 4 provides a framework for explaining the experimental observations on the assumption that the cytochrome chain which reacts with oxygen can also react with the products of the photolysis of water. The respiratory chain has as its terminal enzyme a carbon monoxide- and cyanide-sensitive oxidase. Cytochrome c_2 is largely reduced in the aerobic steady-state because of the large ratio of reductase to oxidase activity for this component; but it becomes oxidized upon inhibition of reductase activity by phenylmercuric acetate. In the absence of this inhibitor, an oxidant, such as hydroxyl radicals derived from the photolysis of water[14], can react with the oxidase, as evidenced by the inhibition of respiration on illumination[15] and by the anaerobic oxidation of the cytochrome system. The reaction of the oxidase with hydroxyl radicals differs from its reaction with oxygen in that the former reaction is not inhibited by carbon monoxide or cyanide. A direct oxidation of cytochrome c_2 by hydroxyl radicals is unlikely, since it does not occur aerobically. In the mechanism pictured, the oxidase could be either oxidized or reduced by the products of the photolysis reaction; but a photosynthetic hydrogen acceptor system of high activity would cause the oxidation reaction to predominate during illumination and to be followed by a rapid reduction due to accumulated reducing substances (either (H) or H*X* of Fig. 4) that can react directly with the oxidase (Fig. 3*B* shows that the reduction of cytochrome following illumination is faster than the rate caused by cell respiration). The photoreduction observed in the presence of phenylmercuric acetate could be caused by a decrease in the concentration of (OH) or an increase of (H). Two alternative mechanisms are suggested: one an inhibition of carbon dioxide fixation (as is clearly established in other systems, see for example ref. 16); and the other an inhibition of the accumulation of

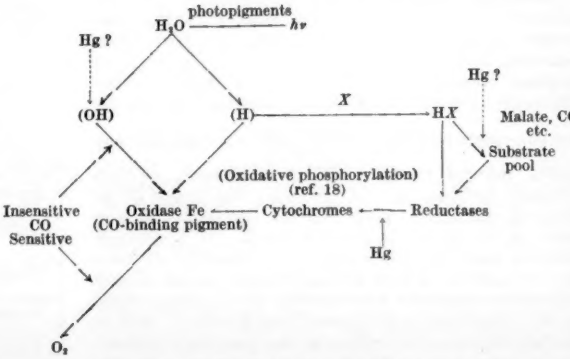

Fig. 4. Hypothetical scheme to explain spectrophotometric effects in *Rhodospirillum rubrum*

hydroxyl ions. In the latter case the hypothetical configurations of thioctic acid[17] combined with the photolysis products of water could afford a basis for selective inhibition of (OH) production by phenylmercuric acetate.

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APPLICATION OF BIOMETRIC METHODS TO PROBLEMS OF CLASSIFICATION IN ECOLOGY

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THE application of Fisher's development of multivariate analysis for discriminatory purposes[1] to problems of plant taxonomy and plant community classification has recently been explored by Whitehead[2], Goodall[3] and Hughes[4].

Mahalanobis, and more recently Rao[5], have used a multivariate analysis technique based on the statistic D^2, calculated from the means, variances and covariances of the quantities measured in the two groups. More precisely, if p quantities have been measured, a_{ij} is the dispersion matrix (i, j 1, 2 . . . p) supposed common to the two groups, and d_i is the difference between the means in the two groups for the ith quantity, then $D^2 = \sum_{ij=1}^{P} a^{ij} d_i d_j$ with a^{ij} the matrix inverse to a_{ij}. D^2 is a measure of the 'distance' between the two groups; the larger D^2 is, the more difference exists between the two groups in terms of the p quantities measured. D^2's between different pairs of groups may be compared. D^2 may also be used as a test of significance to see if any real differences exist between the two groups, based on the characters which have been studied; and in the case of $p = 1$, it reduces to the familiar Student's t-test. The use of this function opens a wide field for its application in ecology.

One use lies in the study of plant communities, where D^2 can be used as a coefficient of similarity between two communities[4].

In Table 1 a summary is given of an example where two communities are compared. From the data the following discriminant function was obtained:

$$9{\cdot}430008xA + 8{\cdot}646360xB + 13{\cdot}375968xC + 0{\cdot}205926xD$$

$$xA = \log(A + 5),\ xB = \log 10B,\ xC = \sqrt{C + 0{\cdot}375},\ xD = \sqrt{D + 0{\cdot}375}$$

The standard errors of the coefficients are respectively: 0·399387, 0·147219, 0·091873 and 0·082622. The D^2 value is 11·647785, which is significant at less than 0·1 per cent probability (ref. 5, pp. 247–48). Hence a real difference exists between these communities according to the species groups which have been studied. This may be extended to several groups and the D^2 for each pair calculated, as has been done by Rao[5] for human races. In this way a 'constellation' of relationships has been worked out for a group of six Snowdonian soil series. The classificatory details of the soil series are set out in Table 2. From the study of the four soil characteristics of exchangeable calcium, potassium, pH and available phosphate, the variate ranges of the quantitative data for each of these characteristics showed considerable overlap from soil series to series. The statistical validity of the classification outlined in Table 2 has therefore to be considered. The means and the variances for each characteristic are set out in Table 3 (because of non-normality of distribution the original quantities have been transformed).

The values of D^2 are set out in Table 4. This enables the original classification to be tentatively revised so that we have only four soil series:

(*a*) Soil series derived from pumice tuff and dolerite rocks under rainfall ranges of approximately 42·5–55 in. and 75 in. mean annual rainfall respectively (series *A* and *C*).

(*b*) Rhyolite soils developed under a rainfall range of 35–60 in. (series *B*).

(*c*) Pumice tuffs and rhyolite soils at high rainfall (60–150 in. and 65–150 in. mean annual rainfall

Table 1. DIFFERENCES BETWEEN TWO PLANT COMMUNITIES
Oak scrub (hybrids of *Quercus robur* and *Q. petraea*). Alt. = 200–800 ft., Conway Valley, North Wales

Ecological class of species within communities	Mean prominence (scale 1–10) of species class in community on soil series		Difference (*R*–*P*)
	R (*n* = 15)	*P* (*n* = 22)	
A	1·28	4·09	− 2·81
B	2·80	2·28	+ 0·52
C	2·90	0·44	+ 2·46
D	2·42	3·07	− 1·65

Class of species: *A*, spp. of *Quercetum roboris*; *B*, spp. of *Q. petraeae*; *C*, spp. of heaths and acidic grasslands; and *D*, spp. of agricultural grassland.
Soil series: *R*, free-draining soils derived from rhyolite (acidic); *P*, free-draining soils derived from pumice tuff (basic).

Table 2. CLASSIFICATION OF SOME SNOWDONIAN SOILS

Soil parent rock	Soil series	Rainfall range	No. of sites		Rainfall range*	No. of sites
Pumice tuff (basic)	*A*	42·5–55	26	*A′*	60–150	36
Rhyolite (acidic)	*B*	37·5–60	18	*B′*	65–150	22
Dolerite (basic)	*C*	42·5–75	59	*C′*	85–135	9

* Rainfall range in terms of mean annual rainfall in inches

* The greater part of the work reported on here was carried out while at the School of Agriculture, Cambridge.

Table 3. MEAN SOIL CHARACTERISTICS OF SIX SNOWDONIAN SOIL SERIES

Soil series	No. of sites	Exchangeable CaO	Available P_2O_5	Exchangeable K_2O	pH
A	26	239·84	2·86	17·21	5·11
A′	36	93·33	1·80	12·45	4·81
B	18	97·28	4·98	20·72	4·52
B′	22	85·36	1·02	10·94	4·51
C	59	205·53	3·57	21·37	4·95
C′	9	103·80	1·74	23·67	4·64

All soil quantities other than pH in mgm. per 100 gm. air-dry soil. Individual variates are weighted means per soil profile.

The present investigation stresses the need for a statistical appraisal of the validity of the classificatory groups established on empirical grounds.

The same example has been considered also from a discriminatory point of view. Thus, suppose we have a chemical analysis of the type described above for a new soil known to be one of the four types isolated by the above analysis. It is possible by a canonical analysis to classify it in the correct class, with, of course, certain possibilities of error which will be smaller the larger the value of D^2. A canonical analysis has been carried out for the same data as used above, and it shows that three linear discriminants are needed. They are: (i) $W + 0{\cdot}29X + 0{\cdot}25Y + 0{\cdot}40Z$; (ii) $W - 1{\cdot}98X - 0{\cdot}60Y + 6{\cdot}31Z$; (iii) $W - 9{\cdot}21X + 21{\cdot}35Y - 34{\cdot}76Z$.

TRANSFORMED QUANTITIES

Soil series	*W*	Variance	*X*	Variance	*Y*	Variance	*Z*	Variance
A	2·322	0·05589	1·446	0·06587	1·319	0·02874	0·705	0·00174
A′	1·900	0·06601	1·216	0·11450	1·196	0·03620	0·678	0·00237
B	1·891	0·11140	1·569	0·15426	1·306	0·09024	0·652	0·00255
B′	1·798	0·09900	1·103	0·07062	1·140	0·06632	0·650	0·00267
C	2·236	0·06004	1·496	0·07786	1·367	0·04488	0·692	0·00181
C′	1·957	0·06558	1·207	0·13040	1·420	0·03885	0·662	0·00524

$W = \log(\text{CaO})$; $X = \log(10\,P_2O_5 + 5)$; $Y = \log(K_2O + 5)$; $Z = \log(\text{pH})$
Transformations to achieve normality of distribution and equality of variances

Table 4. D^2 ANALYSIS OF SNOWDONIAN SOIL SERIES (Index to series see Table 2)

	A′	*B*	*B′*	*C*	*C′*
A	2·66	3·66	4·46	0·26*	3·07
A′		1·91	0·30*	2·18	1·44
B			2·44	2·21	2·48
B′				3·76	1·78†
C					2·09‡

* Not significant; † significant at 5 per cent; ‡ significant at 1 per cent; all others significant at 0·1 per cent. Analysis based on the four soil characteristics of Table 3.

respectively) can be classed as one group (series *A′* and *B′*).

(*d*) Dolerite soils at high rainfall (85–135 in. mean annual rainfall) can be classed in a single group (series *C′*).

Since only four soil characteristics have been studied, this re-classification can only be tentative. This is emphasized in the case of pumice tuff and rhyolite soils at high rainfall, as vegetational differences exist between them.

It is, however, suggested that the present revised classification is a useful 'working' one for ecological purposes, since the four soil properties studied are of known importance to plant growth.

The results are shown diagrammatically in Fig. 1 as a 'map' with points representing the four soil groups, the distances between the points being proportional to D^2. Such a representation of the structure of classificatory relationships can be of value in that the statistical distances (and their significances) between the units can be clearly seen.

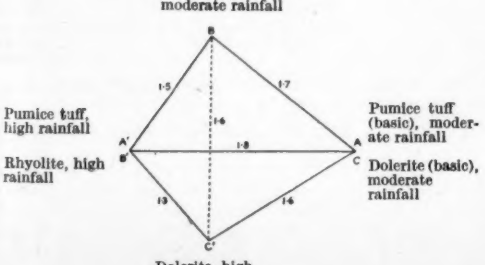

Fig. 1. Map of soil types based on *D*

The following applications of these methods are suggested:

(1) The structure of the classificatory relationships for series derived from the same parent rocks could be compared for a different range of rainfall gradients and other related climatic factors.

(2) Trends in soil development which can be related to specific factors, such as a rainfall gradient as considered here, can be given a quantitative expression, through the distance function D^2. This could be instructive if one or more of the classificatory units are typical of a well-established soil group, or an example of such a group or groups could be introduced into the analysis. The degree and significance of the departure of the soils studied from these typical examples could therefore be expressed in terms of D^2.

(3) Similar considerations apply to the study of plant communities. Trends away from, or towards, a particular kind of community can be expressed in terms of D^2. These might be ascribed to particular environmental factors. Developmental successional trends could also be expressed in a similar manner.

(4) The collation of the D^2 analyses of soil factors (or any other environmental factors) and of related vegetational characteristics could give a quantitative estimation of the part played by a group of particular environmental factors in determining vegetational trends. Here the use of canonical correlation would be an important development. [Dec. 15

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

The Horizon of the Steady-State Universe

In a reply[1] in *Nature* of February 26 to Mr. T. Gold, "The Writer of the Article" quotes statements by me[2] and by Mr. Gold that at first sight seem to contradict one another. Actually there is no contradiction, as I shall show.

First, a word about the 'time' used in cosmology. It was pointed out many years ago by Weyl that the world-lines of the galaxies seem to be distributed in space-time in such a way that a family of three-dimensional surfaces can be drawn orthogonal to them. In such a case, a time co-ordinate can be chosen so that the orthogonal surfaces are surfaces of constant time. With this choice, 'time' is equivalent to 'interval' measured along the world-lines of the galaxies (taken for simplicity to be point masses). This is the 'universal time' of all modern cosmologies, and this is the meaning to be attached to 'time' in this communication.

According to the geometry of the steady-state universe, space-time can be divided into two parts by a critical surface (not a surface of constant time). Our own world-line is entirely contained by one of the two regions. I shall refer to this region as being 'inside' the critical surface, and to the other region as lying 'outside'. A pulse of light from any event inside the critical surface can be detected by an observer using idealized instruments (that is, instruments that detect an infinitesimal amount of energy), the observer being stationed on our world-line and the observations being made in our past, present, or future, according to the particular event in question. In contrast, events occurring outside the critical surface are in principle unobservable, not only in the present but also over the whole of our world-line, past and future. The critical surface thus separates the events that are in principle observable from those events that are in principle unobservable. In my paper[2], the interior of the critical surface was called our observable universe, or simply the observable universe. In making this definition I placed 'observable universe' in inverted commas, as a precaution against the words being used away from their definition.

It may be noted that the corresponding critical surface for an observer in another galaxy is different from our critical surface, and the observable universe (according to my definition) is different too.

The world-lines of receding galaxies intersect our critical surface. Consider the world-line of one such galaxy. It intersects our critical surface at a particular time, t_0 say, and it does so in such a way that the past section of its world-line (times $t < t_0$) lies inside our observable universe—the future section lying outside. We may express this by saying that for $t < t_0$ the galaxy lies within the observable universe; but at t_0 it passes outside the observable universe. This explains what I meant[2] by saying that receding galaxies pass out of the observable universe (t_0 varies, of course, from one galaxy to another).

Now a pulse of light emitted by a particular galaxy at a time before t_0 does not reach us at the moment of emission, since a period of time elapses while the light is travelling to us. This period depends on the moment of emission, and it does so in such a way as to tend to infinity as the moment of emission tends to t_0. It follows, therefore, that even at a time $t > t_0$, we may still be detecting signals from the galaxy; but they must be from events that occurred before t_0. Thus even though at time $t > t_0$ the galaxy lies outside the 'observable universe', we may still be receiving signals from events that occurred before t_0. This explains what Mr. Gold meant in his communication by saying that there is no last moment in our reception of signals from a galaxy, although there is a last moment, namely, t_0, at which signals must start on their journey if they are ever to reach us.

It may be worth noting that to continue indefinitely receiving signals from a galaxy an observer must be equipped with idealized instruments. Peculiar situations would arise in everyday life if such instruments existed in actuality. It would be possible, for example, to observe the actions of a man long dead (trap light from events in the man's life inside a box with perfectly reflecting walls; then release as and when required).

A galaxy 'dies' so far as we are concerned at time t_0, in the sense that its future cannot be observed by us. But we can still keep on observing events in the past history of the galaxy, because these events are 'bottled-up' in space-time to a degree that depends on the transit time of light.

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A Radio Survey of the Great Loop in Cygnus

During the past few years, intense radio sources have been identified with galactic nebulosities in Taurus[1] (the Crab Nebula), Cassiopeia[2], Puppis[3], Gemini[4] (*I.C.*443) and Auriga[5]. One of these five objects (*I.C.*443) bears a marked resemblance to the Great Loop in Cygnus, and it has been suggested[4] that the latter may also be a radio source. The Loop comprises the well-known Network nebulæ *N.G.C.* 6960 and *N.G.C.*6992–5, together with several other patches of nebulosity. A rough sketch of the brighter parts of the system is shown in Fig. 1.

A radio survey of the Loop has been made with the 218-ft. fixed paraboloid at Jodrell Bank, operating at 92·5 Mc./s. At this frequency the paraboloid has a beam-width of about 3° between points of half-power. The results of the survey disclosed the existence of a radio source with the co-ordinates and intensity given in Table 1.

Table 1. Data on Radio Source (Epoch 1950)

Right ascension	20h. 49m. 30s. ± 1m. 30s.
Declination	N. 29° 50′ ± 1°
Intensity	$220 \pm 100 \times 10^{-24}$ watts m.$^{-2}$ (c./s.)$^{-1}$ at 92·5 Mc./s.

The zenith angle of the source is about 23° at Jodrell Bank and it lies at the edge of the field of view of the large paraboloid. At these large zenith angles the elevation and shape of the beam are uncertain, and hence there may be considerable errors in the observed values of declination and intensity. However, in the present case it was possible to check

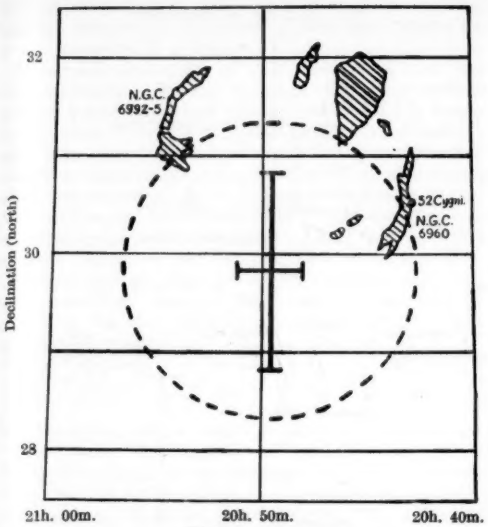

Fig. 1. A sketch of the more prominent nebulosities forming the Great Loop in Cygnus. The position and estimated limits of the centre of the radio source are shown by the cross (full line). The minimum angular diameter of the source is indicated by the circle (broken line)

the calibration of the aerial by observing a reference source of known position and intensity (private communication from M. Ryle) at approximately the same declination (N. 29° 32·5′) as the Loop. As a result of this check, the limits of error shown in Table 1 were established.

An examination of the records suggests that the angular diameter of the source lies in the range 3–6°. Furthermore, this suggestion is strengthened by the fact that the source has not been reported in previous surveys made with interferometers of comparatively high resolving power.

The estimated limits of the position of the centre of the radio source have been plotted in Fig. 1, and it can be seen that it lies close to the Loop. If the nebulosities form part of a roughly spherical object, as photographs of the region indicate, then the position of the radio source probably lies within the outline of this object and towards the lower edge. The angular size of the source has been shown by a circle of diameter 3° and, since this is the minimum value given above, it is clear from the sketch that the angular size of the source is at least as great as that of the Loop.

On the basis of the evidence presented above, it is reasonable to conclude, but only tentatively, that the Loop in Cygnus is associated with the radio source. A more positive identification must await improved values for the declination and angular diameter of the source, and these can only be obtained from some other large instrument with a more favourable field of view.

The presence of this source close to the Loop is of considerable interest and indicates that this object may belong to the class of galactic nebulosities which are radio sources. It also supports the suggestion that the Loop is similar to *I.C.*443 in Gemini, and it is interesting to note that the intensity of the source given in Table 1 is comparable with that observed[4] from *I.C.*443 (425×10^{-26} watts m.$^{-2}$ (c./s.)$^{-1}$ at 3·7 m.). Finally, a radio source in association with the Loop might provide an unrivalled opportunity for studying in detail the correlation between the radio emission and the visible structure of a nebulosity.

We thank Prof. A. C. B. Lovell for his interest in this investigation, and Prof. Z. Kopal for directing our attention to the problem in the course of a lecture given in 1953. One of us (D. W.) is indebted to the Department of Scientific and Industrial Research for a maintenance grant.

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Absorption of Underwater Sound by Substances in Process of Solution

In the course of work on the transmission of acoustic waves through aqueous solutions, we have noticed that solid substances in process of solution become extremely efficient absorbers of acoustic energy. In a typical experiment in which transmission was taking place at 400 kc./s. between transducers 1 ft. apart, the addition of 1 per cent by weight of common salt to the water produced attenuation of the order of 40 db., which was maintained until solution was complete. It was found that similar effects could be produced with all soluble solids, but not with liquids; and that although the amount of attenuation varied, it was in all cases high compared with that produced by insoluble substances.

Quantitative experiments, using a reverberation method which distinguishes absorption from scattering[1], were carried out with the results shown in Fig. 1. It will be seen that one part in 22,000 by weight of 'Analar' sodium chloride produced an attenuation thirty times as great as that normally

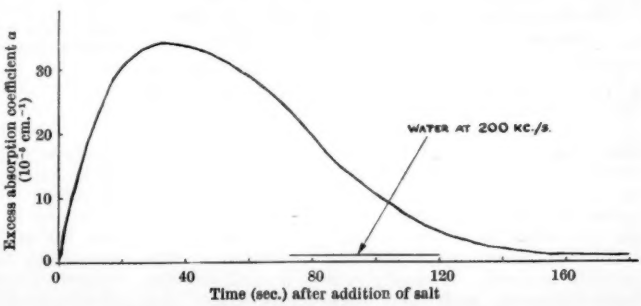

Fig. 1. Absorption of underwater sound by salt in process of solution. Addition of 0·1 gm. sodium chloride, grain size 211–252 μ, to 2·2 litres of water

encountered in water at 200 kc./s. The maximum value of attenuation varied with frequency, being greatest at about 200 kc./s. for the samples used. The time between the addition of the salt and the attenuation reaching its maximum value appeared to be greatest near the same frequency.

The mechanism of this absorption was indicated by two experiments. In one, dissolving salt was illuminated transversely and studied in a microscope. Minute bubbles of gas could be seen leaving the crystals as they dissolved, and it was deduced that these were due to gas occluded in the crystal at the time of formation. In the second, salt was dissolved in water and recrystallized *in vacuo*, and it was found that the attenuating effect produced by the salt was much reduced. The absorption of sound by resonant gas bubbles has been described by several authors[2], and it has been shown theoretically that the diameter of the bubble is proportional to the wave-length of the sound. At 200 kc./s. the resonant diameter for air is 3×10^{-3} cm., so that the bubbles are invisible to the naked eye under normal conditions of illumination. The experimental results were consistent with the evolution of bubbles of this order of magnitude.

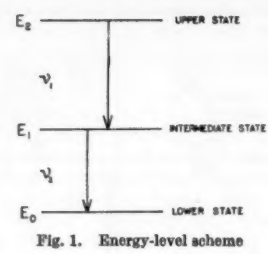

Fig. 1. Energy-level scheme

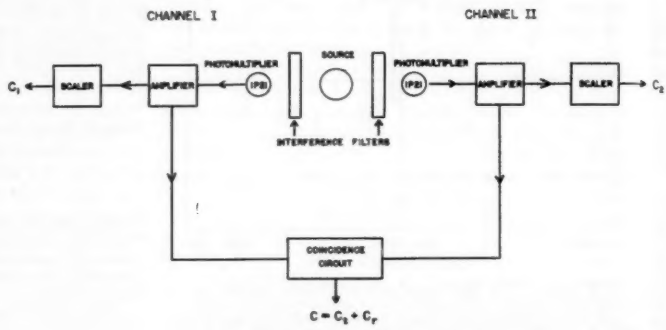

Fig. 2. Experimental arrangement

It has been stated that "a blanket of bubbles is a good absorber of high frequency waves when they traverse a liquid"[3], and the chief interest of the phenomenon described lies in the large attenuation produced by an extremely small quantity of air. It is probable that the average size of bubble depends on the method of preparation of the soluble particles. The method of introducing the bubbles appears to be novel and opens possibilities of good absorbers for use in experimental work.

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Application of Nuclear Coincidence Methods to Atomic Transitions in the Wave-length Range λλ 2000-6000 A.

A recent communication by (the late) S. Heron, R. W. P. McWhirter and E. H. Rhoderick[1] on "Measurements of Life-times of Excited States of Atoms by the Method of Delayed Coincidences" was read with much interest here. Their method consists of exciting a source for 2×10^{-8} sec. and observing the intensity of the light emitted by the source at a given time after the excitation. Thus they observe the behaviour of a large assembly of atoms.

In this laboratory a different approach to the problem is made. A steady source is used and the light observed with two photomultipliers. By observing coincidences between photons emitted in a cascade transition and detected by the photomultipliers, the behaviour of individual atoms is observed. Since this application of nuclear coincidence techniques[2] has numerous potentialities not found in other methods, we feel it is of interest to comment on it briefly.

The method is illustrated by considering the simple energy-level scheme of Fig. 1. This may be assumed to apply to the atoms in the source, radiation from which is observed by two 1*P*21 photomultipliers arranged as in Fig. 2.

By means of appropriate interference filters, each photomultiplier is rendered sensitive to light of one frequency (the first to ν_1, the second to ν_2). The pulses due to single photons from these cascade transitions are fed to standard coincidence circuits, and the total coincidence-rate C is recorded together with the single-channel rates C_1 and C_2. The total coincidence-rate is composed of a 'true' coincidence-rate C_t (due to the simultaneous detection of photons emitted in cascade from the same atom), and a purely random coincidence-rate C_r (due to accidental coincidences of photons emitted by different atoms).

If we suppose N atoms per sec. enter the upper state E_2 and that the life-time of the intermediate state E_1 is much less than the resolving time 2τ of the coincidence circuit, then[2]

$$\begin{aligned} C_1 &= N\varepsilon_1 \\ C_2 &= N\varepsilon_2 \\ C_t &= N\varepsilon_1\varepsilon_2, \end{aligned} \qquad (1)$$

where ε_1, ε_2 are, respectively, the total efficiencies of channels I, II for the detection of photons of frequency ν_1, ν_2 emitted by the source. The total efficiency is a product of the geometrical efficiency and the intrinsic efficiency of the detecting system. It should be emphasized that C_1, C_2 and C are measured, and that C_t can be calculated from $C = C_t + C_r$ and $C_r = 2\tau C_1 C_2$. From the three equations (1) the absolute strength of source N and the efficiencies ε_1 and ε_2 can be deduced. This is

the first advantage of the nuclear coincidence method, namely, that it is a means of absolute calibration of the strength of a source.

A second advantage of this method is that one can determine directly whether the intermediate state is being populated or depopulated by a mechanism other than the radiative transitions observed, since true coincidences occur only between these two radiative transitions. If a fraction K of the atoms which enter state E_1 from E_2 by a radiative transition perform the radiative transition to E_0, this appears in the true coincidence-rate as $C_t = K N \varepsilon_1 \varepsilon_2$. Thus relative transition probabilities can be measured.

Finally, the life-time of the intermediate state can be measured[3] by delaying the pulses from the channel observing the first transition, before feeding to the coincidence stage.

Experimentally it is necessary (*a*) to maintain a low strength of source $\left(\text{about } \frac{1}{2\tau}\right)$ to keep C_t/C_r high, and (*b*) to maintain ε_1 and ε_2 high by good geometry.

This direct application of nuclear coincidence techniques allows one to measure (1) absolute source strengths, (2) efficiency of the detection apparatus, (3) relative transition probabilities, (4) rates of mechanisms which populate an intermediate level, (5) life-times of intermediate states, and (6) angular correlations between the directions of emission of photons in cascade transitions.

Note added in proof. By this method the life-time of the 7^3S_1 state of mercury has been found to be $1{\cdot}12 \pm 0{\cdot}02 \times 10^{-8}$ sec. The upper transition arose from the ionization continuum and the lower transition was $7^3S_1 \rightarrow 6^3P_1$ (λ 4358·34 A.).

This work is being carried out as part of a project sponsored by the Geophysics Research Directorate, Air Force Cambridge Research Center, under Contract *AF* 19(122)–470.

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Small-Angle X-Ray Diffraction Patterns of Collagen

In the investigation briefly reported here, the collagen fibres used were from beef achilles tendon. The diffraction patterns were obtained with an evacuated camera and a rotating anode X-ray tube having a copper or chromium target. The results discussed refer only to copper $K\alpha$ radiation; the chromium target was used solely for confirming intensity measurements. The observations on dry collagen were made with vacuum-dried fibres which remained *in vacuo* throughout the experiments, whereas wet fibres were mounted in a cell with beryllium windows and remained in a saturated atmosphere for the duration of the exposure. Photographs were obtained from which measurements were made of the intensities of twenty-five orders in the pattern for wet fibres, and twenty-three orders in the case of dry fibres. Exposure times involved may be indicated by giving the times required to give an intensity in the first order of $D = 1{\cdot}0$ above the background. For dry achilles tendon this time was 2·5–3 hr., whereas for wet fibres the time was about thirty minutes, the apparatus running under identical conditions with the tube operated at 30 kV., 80 m.amp. The long spacing d of the dry fibres was 635 A. and for the wet fibres 670 A.

A particularly interesting feature of the diffraction patterns was the appearance of relatively strong reflexions at the nineteenth and twentieth orders for dry fibres and at the twentieth and twenty-first orders for wet fibres. These results are set out in Table 1, in which the intensity scale is such that the first-order intensity is 1,000.

Table 1

Order n	Dry fibres		Wet fibres	
	Intensities	d/n	Intensities	d/n
18	7	35·2	1	37·2
19	10	33·4	0·5	35·2
20	10	31·8	5	33·5
21	7	30·2	4	31·9
22	4	28·8	2	30·4

It may be remarked that the nineteenth to twenty-first orders were well resolved, and there is no indication that the enhancement of the intensities is due to superposition on a diffuse line covering the two adjacent orders of the small-angle pattern. Apparently the Fourier transform of the electron density distribution along both wet and dry fibres has a pronounced maximum corresponding to a spacing of 31–34 A., centred approximately on 32·8 A. There is therefore a suggestion that, although the long spacing of collagen may vary considerably, there is nevertheless a constant structural unit of about 32·8 A. in length.

Some attempts have been made to label specific amino-acids with heavy atoms and to observe the resulting small-angle diffraction patterns. According to Grassmann and Kusch[1], histidine combines with silver when collagen fibres are treated with silver nitrate, and with lead when treated with lead acetate. We found that the silver treatment considerably modified the small-angle pattern, but the lead treatment had no effect. On the other hand, the wide-angle pattern is not affected by silver, but shows rings which may be attributed to the deposition of granules of lead acetate on the fibres. It appears that silver does in fact enter into chemical combination with the protein, but not lead. Treatment with iodine dissolved in potassium iodide solution, which may be expected to result in attachment of iodine to tyrosine, has also been found to modify considerably the small-angle pattern. Patterson functions are being calculated for the different patterns observed; but so far it appears that silver is not a sufficiently heavy atom to show up clearly in the Patterson plot.

A full account of this work will appear in due course when observations on kangaroo tail tendon fibres have been completed.

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Derivatives of Caffeic Acid in Sweet Potato attacked by Black Rot

SEVERAL polyphenols have been found to be accumulated in the sound part next to the injured tissues of sweet potato attacked by black rot caused by *Ceratostomella fimbriata*, and chlorogenic acid, caffeic acid and *iso*chlorogenic acid have been isolated as well as the two kinds of new caffeic acid derivatives. Previously, G. O. Rudkin and J. M. Nelson[1] had isolated chlorogenic acid and a group of components giving caffeic acid by alkaline hydrolysis from sound sweet potato.

Extraction and fractionation of the material were carried out chiefly by the method of Rudkin and Nelson. Sound tissues taken from sweet potato suffering from black rot were extracted with acetone, polyphenols in the extract were converted to the lead salts, which were decomposed with dilute sulphuric acid, and the resulting solution was shaken with ethyl acetate; from the ethyl acetate layer (upper) crude polyphenols were separated. These crude polyphenols were dissolved in phosphate buffer (*p*H 4·7) and shaken with an equal volume of ethyl acetate; the buffer layer (lower) was adjusted to *p*H 2·0 and shaken with ethyl acetate, the ethyl acetate was concentrated and the crystalline chlorogenic acid (m.p. 205–6°) was obtained by adding chloroform to it.

The remainder of the ethyl acetate layer, separated from the buffer layer, was concentrated, and, by adding petroleum ether gradually, polyphenols in this layer were divided into two parts, which were quickly precipitated and slowly precipitated respectively. From the latter caffeic acid (m.p. 192–94°) was removed as crystals. The former was subjected to 44-transfer counter-current distribution using phosphate buffer (*p*H 5·8) and ethyl acetate as solvents. As the result, it was divided into three fractions, *A*, *B*, *C*, having partition coefficients 0·48, 1·36 and greater than 40 respectively. *A* and *B* were collected and again subjected to counter-current distribution. They gave curves corresponding with the theoretical curve, proving their freedom from impurity; but they have not been crystallized in the free form and derivatives have not been prepared. It is not known whether *C*, a white powder, is a single polyphenol or not.

A, *B* and *C* were decomposed with alkali, and separated in crystals into caffeic acid (yield 100 per cent each) and quinic acid (60 per cent each). Each caffeic acid was identified by mixed melting point (192–94°) and elementary analysis, further confirmed by those of methyl caffeate derived from it. Each quinic acid was also identified by mixed melting point (168–69°) and elementary analysis of its brucine salt.

The ultra-violet absorption spectra of *A*, *B* and *C* were almost the same as that of chlorogenic acid. Infra-red absorption spectra of *A* and *B* were very similar, but they were different from that of chlorogenic acid, while that of *C* was not like either of them. The optical rotations of *A*, *B* and *C* were $[\alpha]_D^{13} - 155°$, $[\alpha]_D^{13} - 196°$, and $[\alpha]_D^{13} - 94°$; and the neutral equivalents of *A* and *B* were 586 and 563 respectively; *C* had a large value and seemed a polymer. The properties of *B* were similar to those of *iso*chlorogenic acid ($[\alpha]_D^{20} - 230°$, neutral equivalent *c.* 580, rate of oxidation by periodic acid, etc.) isolated from coffee beans and investigated by H. M. Barnes and W. V. White[2]. We also attempted to separate *iso*chlorogenic acid from coffee according to the method of Barnes and White, and the acid was subjected to counter-current distribution; the distribution curve was in accordance with that of *B*. Thus *B* was identified as *iso*chlorogenic acid. The lower rotation value of *B* compared with Barnes's might be due either to the different conditions of measurement (rotation was measured at 1 per cent concentration in alcohol solution using a 1-decimetre tube) or to traces of impurity. We have been informed by J. Corse (private communication) that he has isolated *iso*chlorogenic acid from dehydrated sweet potato.

The properties of *A* and *B* are very alike, except for different values in the rotation, partition coefficient, and solubility in ethyl acetate. *A* was found to be present with *B* in the black-rot tissue of sweet potato; but it might be derived from *B* or some other component during isolation. Tentatively, we propose to call *A* pseudochlorogenic acid. We are considering the position of linkage of the caffeic acid with quinic acid. We could obtain no evidence for the presence in the sound part next to the injured tissues of sweet potato of neochlorogenic acid recently isolated by J. Corse[3] from peaches.

We thank Prof. Y. Sumiki and Prof. S. Funahashi, of Tokyo University, and Dr. William V. White, of the General Food Corporation, U.S.A., for their advice, and Dr. J. Corse, of the U.S. Agricultural Research Service, for information and a present of neochlorogenic acid.

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Development of Anopheles A Virus in the Endoplasmic Reticulum of Ehrlich Ascites Tumour Cells

EHRLICH ascites tumour grown as a free cell suspension in the abdominal cavity of mice was inoculated with a mosquito-borne virus, anopheles *A* [1,2], usually propagated in the brain tissue of mice. Some destruction of tumour cells occurred within 5–6 days.

Particles believed to be the virus were identified within tumour cells by electron microscopic examination of ultra-thin sections. As in the case of other viruses studied in thin section[3–5], this virus also shows internal structure, here consisting of a transparent ~30 mμ core, and a compound electron-opaque shell, ~12 mμ thick, giving a total diameter of approximately 55 mμ. (Although the size of anopheles *A* virus has been reported to be larger than 55 mμ [6], recent studies with ionizing radiation by E. Pollard and R. A. Brown indicate a particle-size considerably smaller than that determined by ultrafiltration.) Detailed study of viral foci in serial sections showed them to be localized within what has been variously referred to as the endoplasmic reticulum[7], ergasto-

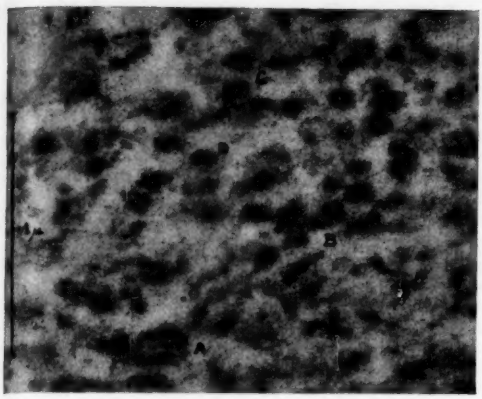

Fig. 1. Particles can be distinguished as embedded in portions of endoplasmic reticulum, as at *A* and *B*, and their linear arrangement can be followed as indicated at *C* and *D*. (× 37,200)

plasm[8] or intracytoplasmic membranes[9]. In Ehrlich ascites tumour cells such a system exists in the form of an interconnecting, primarily canalicular structure best classified as endoplasmic reticulum; virus particles are harboured within its components (Fig. 1), and are not found elsewhere. The localization of the viral particles can be traced in the serial micrographs of Fig. 2. The density of the virus population in any part of the cell varies not only with the number of particles embedded in the particular portion of the endoplasmic reticulum, but also with the degree of organization and closeness of the meshwork in that region, which appears to be intricate and highly flexible. Extensive examination of tumour cells from non-inoculated mice has failed to reveal any particles of comparable structure. Further work is in progress and will be reported in more detail elsewhere.

It is of interest to note that all viruses adequately studied thus far have been shown to possess a complex and characteristic internal structure; moreover, as illustrated by herpes simplex, influenza and the pox viruses[3–5], they may differ widely in the location and mode of development in the cell. Anopheles *A* virus is the first viral agent, however, which has been shown to be intimately associated with the endoplasmic reticulum.

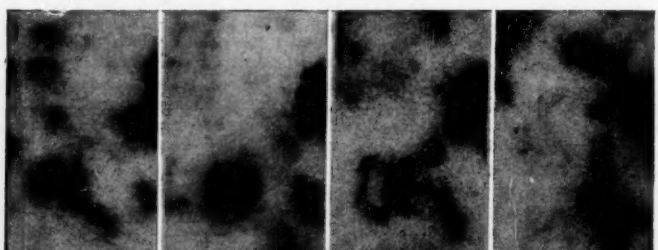

Fig. 2. Four serial sections illustrating: (1) the first intimation of a possible viral particle, surrounded by characteristic cytoplasmic granules, so frequently associated with the endoplasmic reticulum; (2) the appearance of two particles within a membranous sac, with vesicles of endoplasmic reticulum in the vicinity; (3) the distinct vesicular remnant, now devoid of particles; (4) disappearance of portion previously considered but emergence of other branches of endoplasmic reticulum. (× 54,000)

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Sequence of Sexual and Asexual Phases in *Antithamnion spirographidis* Schiffner

THE plants of many Florideae bear either sexual reproductive organs or tetrasporangia, and there is a reasonable amount of cytological evidence in support of the generalization that plants bearing tetrasporangia have twice as many chromosomes as those bearing sexual organs, meiosis occurring in the tetrasporangium. On the other hand, there is surprisingly little evidence from controlled experiments to show that the plants which develop from carpospores bear tetrasporangia and that those which grow from tetraspores bear sexual organs. Lewis[1] allowed either tetraspores or carpospores, whichever were available, to become attached to oyster shells in the laboratory and he then submerged the shells in the sea. From subsequent examination of the shells, he concluded that tetraspore-bearing plants of *Polysiphonia violacea* had developed from carpospores and sexual plants from tetraspores of *Griffithsia bornetiana* and *Dasya elegans*. The numbers of plants grown were *Polysiphonia violacea* (6), *Griffithsia bornetiana* (60) and *Dasya elegans* (149). Dammann[2] obtained small plants bearing tetrasporangia of *Halarachnion ligulatum* from carpospores, although tetrasporophytes of this species are unknown in the sea. Hassinger's[3] experiments with *Callithamnion collymbosum* were more extensive; but the results were complicated by the fact that in this species some diploid plants bear branches with male and female reproductive organs as well as tetrasporangia.

Since the existing evidence is so limited it seems worth recording the results of a preliminary experiment, which it is not likely will be further elaborated at present, and which demonstrates the

sequence of sexual and asexual phases in the case of *Antithamnion spirographidis* Schiffner. This alga is a native of the Mediterranean but has also been reported from Plymouth by Westbrook[4]. It appears to grow comparatively well in marine aquaria, and the material used in this experiment came from an aquarium in the Zoology Department of this University. My thanks for it are due to Prof. H. Graham Cannon.

Tetraspores were liberated from two plants at the end of October 1954, and the development of plants from nine of these has been followed. After liberation of a few tetraspores, the parent filaments were quickly removed, as minute fragments are capable of rapid attachment by the production of rhizoids and of subsequent development into new individuals. At the end of the month, nine germlings were moved to individual culture dishes, the transfer causing a temporary slowing down in growth. However, by January 12, 1955, spermatangia were to be seen on four plants and procarps on a fifth. Spermatangia were abundant on two of the four male plants. By February 1 procarps could be seen on the remaining four plants. This development of spermatangia on four plants and procarps on five suggests the existence of sex chromosomes and segregation at meiosis in the tetrasporangium; but on February 1 spermatangia were to be seen on the plant on which procarps were found on January 12 and in addition an immature carposporophyte. By February 18 there were numerous mature carposporophytes on this plant. The occurrence of both male and female reproductive organs on one plant indicates the need of a much more extensive experiment. In addition, a few cells resembling tetrasporangium mother-cells were seen on one of the female plants but never any mature tetrasporangia.

Carpospores of *A. spirographidis* were germinated in October 1952 and the resulting plants kept together in one culture dish. By February 1953, numerous tetrasporangia had developed on them. These plants were not grown under the same conditions as the plants raised from tetraspores and so comparison with the time taken for the development of sexual reproductive organs is of no value.

While the numbers of plants involved in this preliminary work is small, the evidence so far as it goes shows that tetrasporophytes develop from carpospores and sexual plants from tetraspores. This appears to be the first record of the development of plants from both tetraspores and carpospores of the same species to maturity and reproduction. It has also shown that carposporophytes develop in less than eighteen days. The preliminary nature of this work must be emphasized, however.

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Juvenility Phenomena associated with Crown Gall

In a review of juvenility phenomena, Allsopp[1] recently emphasized the close apparent connexion between nutrition and the development of juvenile leaf-forms. In this Department the factors affecting regeneration of plants from roots are the subject of a general study[2], in the course of which juvenile characters have been observed on young root suckers produced by several species. These will be described in detail elsewhere, but it may be of interest to refer to a special case which has occurred.

When adventitious shoots grow from root cuttings of raspberries (*Rubus idaeus* L.), the earliest leaves are usually of pronounced juvenile form, especially when they grow (*a*) from thin roots[3], or (*b*) from small pieces of root, or (*c*) from pieces of dying root, or (*d*) at high temperatures. In shoots which continue to develop, successive leaves become progressively more adult in form, first deeply lobed and later compound (Fig. 1, plant *A*).

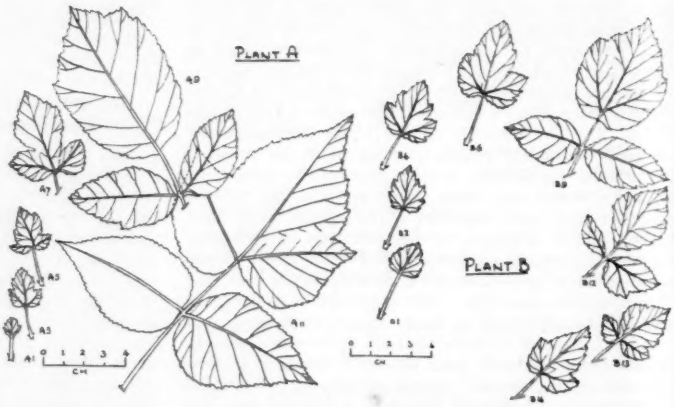

Fig. 1. Form of successive leaves on young Lloyd George raspberry root suckers. Plant *A*, normal; plant *B*, affected by crown gall. Leaves are numbered serially from ground-level towards the apex

However, a few cases have been observed in which the earliest leaves followed the normal sequence, but where the sequence was later reversed, leaves reverting to more juvenile forms (Fig. 1, plant *B*). These plants were examined and in each case were found to bear well-developed basal galls, caused by *Bacterium tumefasciens* E. F. Sm. and Towns. In a large number of plants examined, all shoots reverting to the juvenile form were found to have massive galls, which suggests that juvenility was induced by the effect of the galls.

The plants illustrated were grown in a heated glasshouse and were comparable in age and cultural history.

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Cellulase and Chitinase in Soil Amœbæ

It has long been known that cellulose and chitin are broken down by many species of both bacteria and fungi that can be isolated from soil. It is probable that the soil fauna may also be important in this respect, for it is known that earthworms and eelworms may possess both cellulase and chitinase[1]. Some soil amœbæ were examined to see whether they, too, possessed these enzymes.

'Pure mixed' cultures (a single species of amœba feeding on a single species of bacteria) of three species of soil amœbæ[2] grown on non-nutrient agar were harvested, ground between the surfaces of a standard ground-glass joint and incubated with toluene overnight. The extracts were centrifuged and the supernatants examined for the presence of cellulase and chitinase. The bacteria used as food were soil organisms that had been shown to produce neither of the enzymes when grown under similar conditions in the absence of amœbæ. Cellulase activity was detected by following the production of reducing sugar from a solution of sodium carboxymethylcellulose at *p*H 5, or from a suspension of finely divided cellulose precipitated by dilution of a cellulose dispersal in syrupy phosphoric acid. Chitinase activity was detected by following the production of acetylglucosamine from a suspension of finely divided *Sepia* chitin prepared by dilution of a dispersal in concentrated hydrochloric acid. Very little reducing sugar and no acetylglucosamine were formed on incubating the extracts in the absence of substrate.

The results of an experiment in which sodium carboxymethylcellulose was the substrate are shown in Table 1 (the figures for formation of reducing sugar have been corrected by subtraction of the values for appropriate controls). Action of *Helix* cellulase on this substrate stops when 37 per cent of the substrate weight has appeared as reducing sugar calculated in terms of glucose. The figure for grams reducing sugar produced per gram of total nitrogen in the extract was calculated as a means of comparing the extracts among themselves and with the digestive enzymes of *Helix aspersa*. Under similar conditions, this figure for pooled digestive juice of the snail is about 50 gm. reducing sugar per gm. total snail nitrogen, or at least fifteen times as great as the figure for the amœbæ. The figure for the amœbæ may be expected to be low for the following reasons. All the amœbæ were not in the same state of activity, a considerable proportion having begun to encyst; some of the total nitrogen of the harvested material was derived from uneaten bacteria or waste products; and the cellulase of the amœbæ may have been inactivated by dilution and mixing of the enzyme with other components of the organisms (the digestive juice of the snail was removed from the digestive tract and not diluted with the components of the remaining tissues). It is possible, therefore, that the amœbæ may, in terms of activity per gram total nitrogen, have a cellulose-decomposing power of the same order as that of the snail. The extracts were also shown to hydrolyse finely divided cellulose. No increase in the rate of hydrolysis using this substrate was found when 60 μgm. bovine serum albumin per ml. was added to the assay medium—presumably sufficient protein was already present in the medium to swamp any effect of added protein[3]. The maximum dry weight of amœbæ present in each assay varied from 1 to 5 mgm.

Table 1

Food organism	Amœba	Reducing sugar formed (calc. as glucose) as % carboxymethyl-cellulose after 13 days incubation	Reducing sugar (gm.) formed per gm. total nitrogen of extract, 5 days
Aerobacter sp.	*Hartmanella glebae*	8	2·5
„ „	*Hartmanella* sp.	17	3·6
„ „	*Schizopyrenus erythaenusa*	9·5	1·0
Soil organism (4002)	*Hartmanella* sp.	19·3	3·1
„	*Schizopyrenus erythaenusa*	20	1·8

Incubation of finely divided chitin for 17 days at 35° at *p*H 5 with amounts of extract similar to those used when cellulose was the substrate resulted in the decomposition of 30–130 μgm. of chitin. These amounts were about one-fifth of the weight of cellulose broken down under similar conditions.

The amœbæ described are the only soil protozoa that have been shown to possess cellulase and chitinase; but the cellulose-decomposing abilities of ciliates in the ruminant and termite are well known, and it is probable that many other genera of soil protozoa may be active. It would also be of interest to examine some representative mites from this point of view.

I wish to thank Dr. B. N. Singh, without whom this work would have been impossible, and Mr. T. I. Steenson, of the Microbiology Department at Rothamsted, who were each kind enough to supply the cultures used in the experiments described.

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Extraction of Enchytraeid Worms from a Coniferous Forest Soil

The ecology of the terrestrial Enchytraeidae has been neglected mainly because of the lack of an adequate technique for assessing population size and partly because of taxonomic difficulties. Recently, Overgaard Nielsen[1] has described a method for the large-scale extraction of these worms from soil. This consists of heating soil cores in an earthenware cylinder over a water-bath, and driving the worms upwards into a layer of cooled sand on top of the soil. The enchytraeids are then recovered by washing from the sand.

Studying the enchytraeid population of a coniferous forest soil, this method was not found to be satisfactory, despite attention to detail. Too many dead worms were found in the core, particularly in the litter layer. Therefore an attempt was made to improve on the alternative technique mentioned by Nielsen, in which heat is applied from above to soil spread out on a sieve resting in a funnel full of water. The worms present move downwards through the sieve into the funnel and can be drawn off. This technique was developed, using soil cores from a pure

stand of Douglas fir near Bangor, Caernarvonshire. Their profile shows a natural division into litter, humus and soil layers. Cores of 6·3 cm. diameter and 6·0 cm. depth were taken and subdivided into these layers before extraction. This reduced the bulk of soil in each extractor and provided data on stratification of the worm population. Samples were taken using a corer split longitudinally so that it could be opened and the core subdivided without forcing it out of the corer; this minimizes risk of damaging organisms by compression.

The two methods were compared using material from the above site, ten pairs of soil cores being taken side by side. One of each pair of cores was extracted by the Nielsen method, the other by the wet-funnel method. The litter layer was excluded from the comparison because of its lack of uniformity, and because the worms seemed to find difficulty in traversing the loosely packed litter in Nielsen's type of extractor. In the wet-funnel method the humus was treated as a single sub-sample, and the soil layer was subdivided into two 2-cm. sub-samples; in the other method, the core was treated as a unit. For each of the ten pairs the wet-funnel method gave the higher value, and the average figures were 107·8 (S.D. ± 64·7 coeff. var. 60 per cent) for the Nielsen method and 313·9 (S.D. ± 176·4 coeff. var. 56 per cent) for the wet-funnel method. Even if the worms are not randomly dispersed, such a contrast seems to point to a greater efficiency for the former method. A '*t*' test shows the means to be significantly different ($t = 3{\cdot}29$, $P < 0{\cdot}01$).

On the evidence from the pilot experiment, an apparatus has been designed to deal with large-scale routine extractions. Each extraction unit consists of an 11-cm. diameter funnel resting in a 9-cm. hole in an asbestos board. A 9-cm. wire-gauze sieve of 30 meshes to the inch rests in the funnel. The bottom of the funnel is closed by a screw clip on a piece of rubber tubing. Heat is supplied from a 60-watt electric light bulb enclosed in a light metal cylinder of 11 cm. diameter and 18 cm. height. The bottom of the cylinder is 1½ cm. from the top of the funnel. Twenty-four such units are wired in parallel, and the heating is controlled by means of a variable resistance. The intensity is increased gradually so that the surface reaches a temperature of approximately 45° C. after 150 min., when extraction is complete. Then the worms are run out from the bottom of the funnel for counting and identification.

The reason for the greater efficiency of the wet-funnel method is obscure. The personal element, the depth of soil to be traversed, and the type of soil may be factors. Nielsen's comparative lack of success with the wet-funnel method is surprising. He used a much larger apparatus—420 c.c. of soil extracted on a single sieve of 35 cm. diameter—and sample material from a *Brachypodium* grassland. The wet-funnel method is convenient because extraction is a single process, and heat control is easy. It seems well suited to a coniferous soil lacking ground vegetation, but its suitability for other types has not been examined.

The wet-funnel method has been used weekly over the past six months. During this period population densities, based on the mean of ten samples, ranged from 11·2 (coeff. var. 45·6 per cent) to 25·7 (coeff. var. 67 per cent) per sq. cm. The maximum density of more than a quarter of a million per square metre is much higher than any previously recorded for a comparable habitat. Short-term fluctuations of the population occur; but the cause of these is not yet known. Examination of vertical distribution indicates that 90 per cent of the worms occur in the top 6 cm. of the profile, 79 per cent of these in the humus layer. This distribution is not only quantitative but also qualitative, and different species of enchytraeid dominate the various layers of the profile. Five types of worm have been noted so far; but identification is not yet complete.

I am indebted to Dr. T. B. Reynoldson for his interest in the problem. The work is being financed by a research grant from the Department of Scientific and Industrial Research.

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Pumilin, a New Antibiotic from *Bacillus pumilus*

Although it had been observed that strains of *Bacillus pumilus* produce substances with antibacterial activity, very little work has been done to isolate these substances. Gilliver[1] observed the antibacterial activity of strains of *B. pumilus*, but made no attempt to isolate the active principles. Dvonch and Benedict[2] isolated an antibacterial agent from a strain of *B. pumilus* which they showed to be similar to subtenolin, an antibiotic from *B. subtilis*. Borowski and others[3] obtained an antibiotic, tetaine, from a strain of *B. pumilus*.

Pumilin is produced by a strain of *B. pumilus* isolated from a sample of soil collected by Dr. R. K. Callow, of this Institute, in northern Nigeria during an expedition organized by the Medical Research Council for the survey of medicinal plants in 1949–50.

The antibiotic is obtained in good yield from a 24-hr. aerated submerged culture in a simple synthetic medium containing ammonium citrate or phosphate as a source of nitrogen, and glucose, glycerol or cane sugar as a source of carbon. Several successful batches of about 60 gallons each were fermented in a 100-gallon tank at the Medical Research Council's Antibiotic Research Station in Clevedon, Somerset.

The broth, after adjusting to *p*H 7, was autoclaved at 15 lb. for 25 min., cooled, and ammonium sulphate (40 per cent w/v) added. After settling for a few hours, the precipitate was decanted off from the clear liquid layer and extracted with ethanol. Ethanol was removed under reduced pressure, and the dry material obtained was extracted several times with acetone. Acetone was evaporated off and the residue extracted with benzene, which removed an oil and two inactive crystalline compounds of melting point 117·5° and 120°. The insoluble part in benzene was extracted with 2 per cent sodium bicarbonate solution for three days in the cold room and the precipitate was separated and repeatedly extracted with small quantities of absolute alcohol. The alcohol-insoluble fraction was dissolved in 85 per cent acetone and passed through a column of alumina which adsorbed a dark brown impurity. The effluent was evaporated to dryness and the yellowish product obtained was extracted with very small quantities of 85 per cent

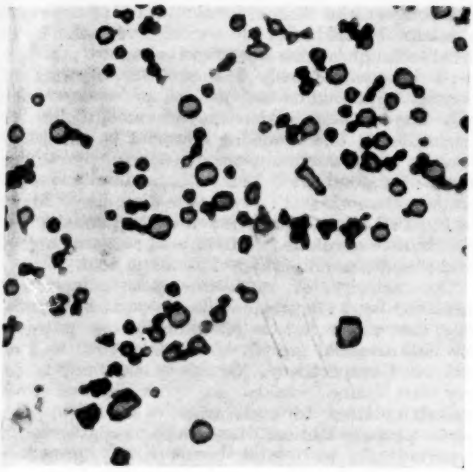

Fig. 1. Crystals of pumilin. (× 200)

acetone, which removed a more soluble brown impurity, leaving pumilin as a lemon-yellow compound. About 700 mgm. were obtained from 500 gallons of broth.

Pumilin crystallizes from *n*-butanol as small hexagonal crystals with average diameter of 10μ (Fig. 1). It does not melt below 360° C. It is sparingly soluble in warm methanol and ethanol, slightly more soluble in aqueous acetone (85 per cent ; 1 mgm./ml.) and soluble in pyridine, collidine and morpholine. Its solution fluoresces strongly in ultra-violet light and rapidly loses activity in ultra-violet light and sunlight, and more slowly in diffused light with a decrease in fluorescence. It does not diffuse through agar even in the presence of detergents, and hence cannot be assayed by diffusion methods. It dissolves in *N*/20 sodium hydroxide solution without loss of activity. The infra-red spectrum shows the presence of a hydroxyl group; but it gives no colour with ferric chloride. In 5 *N* hydrochloric acid at room temperature it quickly turns a copper-red with slight decrease in the activity, the change of colour being irreversible. It is antagonized *in vitro* by horse serum, and it is also inactivated slowly in nutrient broth at 37° C. It is unaffected by cysteine.

Pumilin is active against Gram-positive organisms only. *In vitro* activities of pumilin and penicillin (sodium salt, 1,650 u./mgm.) against a few organisms are shown in Table 1.

Table 1

	Inhibition dilution (× 10^6)			
	S. aureus	*Str. haemolyticus*	*Str. faecalis*	*P. septica*
Pumilin	400–500	400–500	50–125	20
Penicillin (sodium salt)	50–80	150–300	<1	<1

Pumilin is highly toxic to white mice when given as a suspension by the intraperitoneal route (*MLD*, 750 μgm./kgm.). The tolerated dose by the subcutaneous route is, however, much higher (*MTD*, 50 mgm./kgm.). It fails to protect white mice infected with *Str. haemolyticus* when treated with tolerated doses by either route.

Pumilin contains about 1·5 per cent nitrogen. When chromatographed on paper with butanol/acetic acid as the solvent, it gives no spots with ninhydrin; but the hydrolysate obtained with 5 *N* hydrochloric acid gives seven ninhydrin-positive spots.

Most of the antibiotics of bacterial origin are polypeptides, but the molecule of pumilin seems to be largely non-peptide in nature.

Details of this work will be published elsewhere. I thank Dr. A. T. Fuller for his interest in this work and for carrying out the animal experiments.

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Location and Innervation of the Corpus Cardiacum in the Larvæ of some Calliphorinae (Diptera)

The retrocerebral endocrine organs of the third instar larvæ of *Calliphora erythrocephala* Mg., *Calliphora vomitoria* Linn., *Lucilia sericata* Mg., *Lucilia caesar* Linn., and *Protophormia terrae-novae* R–D. have been examined, by direct dissection with methylene blue supravital staining and in serial sections, in order to elucidate a number of hitherto obscure points. Descriptions of these organs in *C. erythrocephala* are given by Thomsen[1] and by Possompes[2] but disagree in some details. The latter's term 'peritracheal glands' for the large cell component of the ring of Weismann[3] has been adopted here.

In *C. vomitoria*, *L. sericata*, *L. caesar* and *P. terrae-novae* the corpus cardiacum is incorporated *in toto* in the ventral wall of the aorta above the larval brain. During the post-feeding prepupation phase (except in *Lucilia* larvæ in diapause) it is clearly delimited by its content of bluish material identifiable as neuro-secretory material by Gomori's chrome–hæmatoxylin–phloxin stain and demonstrable by dark-field microscopy.

In *C. vomitoria*, *L. sericata* and *L. caesar*, the ring is solely formed by the two peritracheal glands, which unite at their ventral point of junction with the aorta behind the posterior limit of the corpus cardiacum, the dorsal branch of the recurrent nerve entering that organ at this point. Dorsally, these peritracheal glands unite above the aorta, where they overlie the corpus allatum and form an anterior prolongation which is attached to the cephalopharyngeal band as described by Possompes in *C. erythrocephala*.

In the latter species, the corpus cardiacum is similarly situated, but it is prolonged downwards towards the brain and partly enveloped by the peritracheal glands at their ventral junction to form an integral part of the ring. In *P. terrae-novae* larvæ, at the cessation of feeding, the separate identity of the two peritracheal glands is clear. They are attached ventrally to the aorta on either side of the corpus cardiacum at its posterior end, and dorsally there are two anterior prolongations attached to the single cephalopharyngeal band. Furthermore, these glands are not attached to the two cerebral tracheæ as in the other species. There is a unique tracheal supply

to the peritracheal glands and the corpus cardiacum arising from the proventricular tracheal system in this, the only species with tracheæ entering the corpus cardiacum.

There are in all species two pairs of nerves from the brain to the corpus cardiacum, as Burtt[4] recorded in *C. vomitoria*. Only one pair issues from the cerebral commissure, the thinner pair identified by Thomsen as the internal nerves of the corpus cardiacum (NCC I), which join the anterior part of the corpus cardiacum. The two thicker nerves which he identifies as the external nerves of the corpus cardiacum (NCC II) issue from the posterior inner faces of the cerebral hemispheres in the location indicated by Possompes for the only NCC he recognizes. Owing to the downward extension of the corpus cardiacum these nerves are shorter and less readily detectable in *C. erythrocephala*. Possompes notes two fine strands in the vicinity of the nerves, joining the brain and the ventral region of the ring, the nervous nature of which is not evident, implying that these may have been wrongly identified as nerves. These may, in fact, be the two fine strands of contractile fibres joining the lateral wall of the aorta above the corpus cardiacum to the connective tissue sheath of the cerebral hemispheres beside the point of entry of the NCC II on each side.

Thus the ring in larvæ of Cyclorrhapha is not, as hitherto published accounts might suggest, invariably a three-component structure, and the corpus cardiacum does not always form an integral part of the ring. There are two pairs of NCC in the Calliphorinæ examined so far, and so the general statement of Cazal[5] derived from observations on larvæ and adults and supported by Possompes, that there is total extracerebral fusion of the NCC in all Diptera, is not tenable, though it may be valid so far as adults are concerned. The arrangement of the retrocerebral endocrine organs and their tracheal associations is similar in *C. vomitoria*, *L. sericata* and *L. cæsar*, with a variation in the location of the corpus cardiacum in *C. erythrocephala*. The divergence in *P. terræ-novæ* is so great as to cast doubt either on its present taxonomic position or on the value of these internal anatomical details as taxonomic features.

Fuller accounts of these investigations will be published elsewhere.

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Putrescine as an Essential Growth Factor for a Mutant of *Aspergillus nidulans*

Nothing is known of the metabolic function of diamines, such as putrescine and cadaverine, in spite of their widespread occurrence in Nature. Putrescine has been reported as a growth factor for certain strains of *Haemophilus parainfluenzae*[1] and of *Neisseria perflava*[2]. There appears to be no report of a fungus requiring it.

Among a series of nutritional mutants of *Aspergillus nidulans* obtained after ultra-violet irradiation by the usual techniques[3], one was found to require putrescine (1 : 4 butane-diamine), 1 mgm./litre allowing full growth. Spermidine can replace putrescine, but is only one-tenth as active at the same molar concentrations. The following compounds structurally related to putrescine were inactive: pyrrolidine; 1 : 4 butane-diol; 1 : 2 ethane-diamine; 1 : 3 propane-diamine; 1 : 5 pentane-diamine (cadaverine); 1 : 6 hexane-diamine; 1 : 7 heptane-diamine; ornithine; citrulline; adipic acid; α-amino-adipic acid; and α-amino-δ-hydroxy-valeric acid.

The activity of putrescine was competitively inhibited by 1 : 3 propane-diamine and by cadaverine, the molar ratios of inhibitor to putrescine for half-maximal growth being about 600 to 1 and 300 to 1 respectively. Ornithine was not inhibitory but lysine weakly so, possibly due to its decarboxylation to cadaverine. In *Haemophilus*, 1 : 3 propanediamine and also cadaverine are reported not to inhibit competitively growth on putrescine[1b].

The hereditary difference between parent strain and mutant of *Aspergillus* is determined by a single gene as shown by appropriate crosses.

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Extraction of Pigment from Cooked Cured-Meat Products

It is well known in the food trade that the colour of cooked cured-meat products fades rapidly on exposure of the products to air and light, the rapidity of fading increasing with the intensity of the light, and being particularly marked if the proportion of light of shorter wave-lengths is large. A considerable amount of investigation has been carried out in recent years into the chemistry of cured-meat products and of model nitrite–hæmoglobin systems, much of it with this practical problem in mind. Investigations have been rendered more difficult by the fact that denatured globin–nitric oxide myohæmochrome—the pigment to which cooked cured-meat products are generally agreed to owe their colour—is insoluble in most solvents. A method has been developed in these laboratories whereby an important part of the molecule—the highly coloured nitric oxide hæm moiety—can be rendered soluble in some organic solvents by treatment of the cooked cured meat with acetone. This greatly facilitates measurement of its spectroscopic characteristics and its general behaviour towards light, oxygen, etc., measurements from which some inferences may be drawn about the behaviour of the parent pigment.

Haldane[1] obtained a weak solution of coloured material from cooked salted (cured) meat by extraction with alcohol. During experiments in these laboratories, it was found that considerably more pigment

could be obtained in solution if ground cooked cured meat was extracted with acetone rather than with alcohol. Even readier extraction was obtained if the ground meat was first well wetted with acetone and then extracted with diethyl ether. The resulting solution was bright red in colour, and measurement of the absorption spectrum in a 'Unicam' *S.P.* 500 photoelectric absorption spectrophotometer showed the presence of three absorption bands with maxima at 563, 537–42 and 480 mμ. Qualitatively, closely similar absorption curves were obtained using either beef or pork as the source of the pigment, though beef, having a much higher initial myoglobin content, gave much stronger solutions. The position of the maximum extinction of the β-band varied somewhat with the species and the solvent used, the range being indicated above (pork, in acetone, 537 mμ; beef, in acetone, 540 mμ; beef, in acetone–ether, 542 mμ).

The ethereal solution obtained by this method contained appreciable quantities of water and acetone, but appeared to be free from protein. Moreover, on shaking the ethereal solution with dilute alkali, the coloured material passed into the aqueous layer, without any apparent major change in spectrum, as viewed through a Hartridge reversion spectroscope. (This alkaline solution rapidly became cloudy, so that fuller measurements of the spectrum were not possible.) Even on the addition of sodium hydrosulphite to this alkaline solution, no hæmochrome bands could be detected in the spectrum. If now an alkaline solution of globin was added to this solution, however, a typical two-banded hæmochrome spectrum at once appeared.

If cooked cured meat was extracted directly with alkali (0·5 *N* sodium hydroxide) the absorption curve of the resulting solution was fairly similar to that of an aqueous solution of unheated nitric oxide myoglobin, having maxima at 576 and 542 mμ. Addition of sodium hydrosulphite to this solution resulted in the immediate appearance of a typical hæmochrome spectrum.

From these findings it was at first thought that the material obtained in the ethereal extractions of cured meat was nitric oxide hæm. Attempts were therefore made to produce this compound from hæmatin in ethereal solution. This could only be done, however, in the presence of acetone, and it was realized that the compound is probably a loose nitric oxide hæm – acetone complex similar to the hæm – acetone and hæm – alcohol complexes previously described[2]. It can readily be formed by pouring a solution of acid hæmatin in ether into a few drops of aqueous acetone in which have been dissolved a small crystal of sodium nitrite and a small amount of sodium hydrosulphite. The product prepared in this way has an absorption spectrum identical with that obtained by an acetone – ether extraction of cured-meat products ($\lambda_{max.}$, β-band, 541 mμ).

Preliminary studies of this red nitric oxide hæm – acetone compound have shown that it is sensitive to light in the presence of oxygen, a solution turning brownish-yellow on exposure. Exclusion of either light or oxygen greatly increased its stability. The absorption curve of the light- and oxygen-affected solution is almost identical with that of acid hæmatin in ethereal solution, showing distinct maxima at 640, 541 and 510 mμ, with a slight shoulder on the curve at 585 mμ.

It is hoped to publish a fuller account of the properties of this compound and related derivatives elsewhere. We thank the Director and Council of the British Food Manufacturing Industries Research Association for permission to publish this communication.

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Mechanism of Sclerotin Formation: the Participation of a Beta-Glucoside

Sclerotin, a skeletal material commonly found in invertebrate animals[1], was shown by Pryor[2] to consist of protein, hardened by reaction with an *o*-quinone. He gave an account of the formation of the ootheca of the cockroach, *Blatta orientalis*, which is composed of sclerotin. The ootheca is derived from the secretions of the two colleterial glands, and it is the larger left gland that secretes the structural protein. Pryor found that a phenolic substance, later shown to be protocatechuic (3 : 4-dihydroxybenzoic) acid[3], was abundantly present in the fluid within the ootheca, and he attributed the secretion of this phenol to the right gland. There was evidence for supposing that this oxidation to a quinone was enzymatic.

The results of our experiments with the colleterial glands of both *Blatta orientalis* and *Periplaneta americana* do not entirely support this explanation. In agreement with Pryor and others[3], the presence of protocatechuic acid in the ootheca has been demonstrated chromatographically and spectroscopically. Also, the protein secretion of the left gland has been found to be converted to sclerotin if it is incubated with synthetic protocatechuic acid, or the oothecal fluid (containing the natural acid), or with homogenized right-gland tissue. All attempts, however, to detect protocatechuic acid in the right gland have failed. Homogenates, extracts and hydrolysates of the gland have been found to contain only small amounts of phenols, none of which is protocatechuic acid. The colour reactions of the gland with ferric chloride, argentammonium solutions, and diazonium compounds bear no relation to the very intense reactions given by oothecal extracts. It is concluded that the right gland is not the gland which secretes the phenol operative in the tanning process.

On the other hand, homogenized left-gland tissue, or alcoholic extracts of it, have been found, by the use of paper partition chromatography, to contain considerable amounts of a substance (R_F 0·58 in butanol – acetic acid – water, 4 – 1 – 5) which shows the reactions of a phenol and strongly absorbs ultraviolet light in the region of 250 mμ, but which does not have the reducing properties of a dihydroxyphenol. This substance constitutes some 10 per cent of the dry weight of the gland. After four hours incubation at 37° C. with right-gland tissue, it is converted completely to D-glucose and protocatechuic acid. It is lævorotatory, and it is cleaved by dilute acids and by β-glucosidase preparations. It has chromatographic properties which are identical with those of a synthetic specimen of 3-hydroxy-4-(β-glucopyranosido)-benzoic acid, and of this glucoside extracted from the fæces of locusts injected with protocatechuic acid.

The activity of the secretion of the right gland led us to suppose that it contained a β-glucosidase. In confirmation of this, it has been found that right-gland tissue will bring about the hydrolysis of salicin, a β-glucoside from willow bark. Moreover, a preparation of β-glucosidase from yeast, added to left-gland tissue, has the same effect as the addition of right-gland tissue, namely, liberation of protocatechuic acid and glucose.

Thus, the mechanism of sclerotin formation in this instance can be explained as follows: the left gland contains the protein to be tanned, polyphenol oxidase[4], and the above-mentioned glucoside; the right gland contains a β-glucosidase. At oviposition, when the secretions are mixed, the glucosidase liberates the *o*-dihydroxyphenol. This is oxidized in the presence of the oxidase to the *o*-quinone, which reacts with the protein, making it hard and insoluble. Preliminary experiments indicate that this process is not confined to the glands which secrete the ootheca, but is of widespread occurrence. In the light of the comparative rarity of aromatic glucosides in animals[5], and of the extracellular nature of the reactions, the processes are of considerable biochemical interest.

It should be pointed out that histochemical tests carried out on colleterial gland tissue give most misleading results. The glucoside is readily oxidized by periodic acid, yet the left gland gives no periodic acid/Schiff reaction. On the other hand, the right gland gives a very strong reaction. It is to be supposed that the glucoside, which we have found to be soluble in both water and ethanol, is lost during the preparation of sections. The strong periodic acid/Schiff reaction of the right gland may be due to the carbohydrate present in the enzyme[6].

We wish to thank Dr. Saiyid Ahmad Shafiq, with whom we collaborated for a period, and Prof. A. C. Hardy, Sir Rudolph Peters, and Dr. John R. Baker for advice and encouragement.

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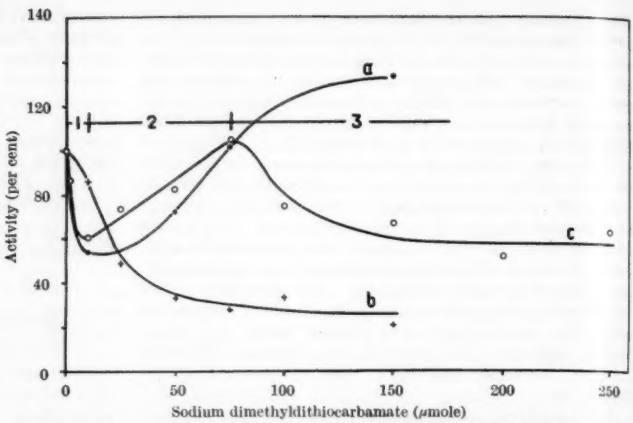

Fig. 1. Action of various concentrations of sodium dimethyldithiocarbamate on the oxidation of acetate by yeast in a phosphate buffer of *p*H 6·3. Curve *a*, 25 micromoles cupric sulphate per litre added. Curve *b*, the same concentration of zinc sulphate. Curve *c*, 15 micromoles cupric sulphate and 25 micromoles zinc sulphate added. The apparent stimulation of the respiration above the control at higher concentrations of the sodium compound in the presence of cupric ions is due to the removal of cupric ions from the substrate

Using ordinary yeast (*Saccharomyces cerevisiae*) as the test organism, it has been found that the oxidation of sodium acetate, in a complete nutrient medium without a source of nitrogen, was inhibited by the same concentrations of sodium dimethyldithiocarbamate that caused growth inhibition. As the oxidation of glucose was considerably less inhibited, it suggests that inhibition is due to reactions connected with the uptake of acetate and formation of acetyl-coenzyme A. Comparative experiments with phosphate buffer alone, and with the various components of the nutrient solution added, demonstrated that the heavy metals had a strong synergistic effect on the action of sodium dimethyldithiocarbamate.

The effect of zinc and cupric ions was examined more closely, and curves *a* and *b* in Fig. 1 were obtained. It was further found that, in a mixture of zinc and copper salts, copper dimethyldithiocarbamate is formed first when sodium dimethyldithiocarbamate is added, the zinc compound being formed when only all cupric ions have been chelated. Copper dimethyldithiocarbamate is thus the more stable of the two complexes. It can be concluded, therefore, that in a mixture of cupric and zinc ions, the action of sodium dimethyldithiocarbamate would at first be similar to that in the presence of cupric ions only; and, after the equivalence point for the formation of the copper compound is reached, it would be similar to that in the presence of zinc ions only. Experiments have shown this to be the case (curve *c*, Fig. 1).

The peculiar shape of the curve of action of sodium dimethyldithiocarbamate in the presence of cupric ions can scarcely be explained by assuming that only one type of complex exists between cupric ions and dithiocarbamate.

A detailed spectrophotometric examination of aqueous solutions of dilute (20 micromoles per litre) cupric sulphate, to which varying amounts of sodium dimethyldithiocarbamate were added, was then undertaken. Using 10-cm. cuvettes in a Cary recording spectrophotometer, curves were obtained which with the smaller additions of the sodium compound showed a peak at 3800 A.; as more of this compound

Reversal of the Fungicidal Effect of Dithiocarbamyl Compounds

A phenomenon which has aroused some speculation is the reversal or inversion of the fungicidal effect of the dithiocarbamyl compounds. First described by Dimond and Heuberger[1], it shows itself as a lack of toxicity at intermediate concentrations, whereas at higher and lower, growth inhibition may be nearly complete. Some explanations have been proposed[1,2]; but none of them so far seems satisfactory.

was added, the peak seemed to disappear, and the normal absorption maximum for the copper compound at 4600 A. (in carbon tetrachloride 4350 A.) emerged. At shorter wave-lengths, the spectra were very similar, with the exception that the maximum at 3100 A. was less pronounced at lower concentrations of the sodium compound.

The peak at 3800 A. seemed to reach a maximum at about the same concentrations of sodium dimethyldithiocarbamate which, in the presence of cupric ions of a similar concentration, caused maximal inhibition of growth and acetate oxidation (about 6 μmoles per litre of the sodium compound). It is assumed that the compound occurring under these conditions, and responsible for the maximum at 3800 A., is the 1 : 1 complex of cupric dimethyldithiocarbamate, namely : $(CH_3)_2 : N—CS_2Cu^+$.

This compound seems to be an intermediate in the formation of the normal 1 : 2 complex, and it does not seem improbable that it may have some stability in very dilute solutions, in the presence of excess cupric ions.

Hence we believe that the action curve of sodium dimethyldithiocarbamate on micro-organisms can be explained as follows : section 1 of curve *c* (Fig. 1) : strong inhibition due to the formation of the 1 : 1 complex of the copper compound ; section 2 : reversal of the inhibition due to transformation of the 1 : 1 complex to the normal 1 : 2 complex, which is practically insoluble ; section 3 : inhibition due to formation of the zinc compound and other heavy-metal complexes with less stability.

It should be mentioned that, besides being valid for all dithiocarbamates (not *bis*-dithiocarbamates), this explanation also applies to the inversion phenomenon observed with tetramethylthiuram disulphide and tetramethylthiuram monosulphide, because these compounds in biological systems have been found to be reduced or hydrolysed to form dithiocarbamate ions.

The findings reported here also explain some of the disagreements found in the literature regarding the toxicity of copper dimethyldithiocarbamate.

A full account of the physiological effect of the dithiocarbamyl compounds on fungi will be published elsewhere.

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Labelling Locusts with Radioactive Isotopes

FOLLOWING successful attempts at marking Lepidopterous larvæ with radioactive sulphur with the object of investigating population dynamics, larval death-rate, and dispersal[1], an opportunity presented itself of applying similar principles to locusts (*Locusta migratoria* L. and *Locustana pardalina* Walk.). Accordingly, a series of laboratory experiments was carried out on (*a*) locust hoppers and (*b*) locust adults. In each case, phosphorus-32 was given and feeding permitted for twenty-four or forty-eight hours, and this was followed by their return to normal food ; thereafter, each having been anæsthetized by carbon dioxide, the individual counts per minute were recorded with a Geiger counter, as also were those for their excreta and exuviæ.

(*a*) *Locust hoppers.* Large numbers of first- and second-instar hoppers were fed on hydroponic maize and grass, grown in solutions of phosphorus-32. Thus the isotope was given in an organic state. Also, sieved wheat bran was impregnated with labelled phosphoric acid, and a strength of 10 μc. of phosphorus-32 per gm. of bran was found adequate. Uniformity of spread was checked by dyes. It was established that 40 gm. of sieved wheat bran would take up 100 c.c. of radioactive solution which, when mixed, gave a satisfactory spread of activity. Rapid drying at high temperature followed by stirring (a mask being worn) was essential ; otherwise fermentation, resulting in deaths of locusts, took place. Known strengths of inorganic phosphorus-32 were thus ingested.

Individuals made radioactive during their first and second instars gave counts easily recognizable three to five weeks later, after they had become adult. There was no apparent difference in this respect between the *gregaria* and *solitaria* phases. The total phosphorus loss (exchange plus decay) after the initial twenty-four hours feed was 80 per cent for the next fortnight.

For the first twenty-four hours following radioactive feeding, each hopper lost about half its radioactivity and, during this period, the excreta gave correspondingly high counts. Thereafter, the loss was negligible. Exuviæ contained very little phosphorus-32.

There was no apparent difference between hoppers that ingested organic phosphorus-32 and those that ingested inorganic radioactive phosphorus.

At a temperature of 85°–90° F., there were, in both cases, individuals which showed very low or no radioactive counts. This was found to be due to the fact that, during ecdysis, the hopper does not feed for a period of about twenty-four hours. A standard error can therefore be worked out for the proportion of hoppers which fail to become recognizably radioactive during their feeding time at a given temperature. This may account for the deficiency of radioactive releases reported by other workers (Putnam, L. G., personal communication) even when sampling is carried out immediately after release.

Among individuals feeding on radioactive hydroponic plants, a much greater uniformity of count was obtained by crowding, so that no one hopper fed exclusively on one leaf. The variance of the leaf counts was thus equalized.

Treated hoppers had a slightly higher mortality rate than untreated hoppers, and death usually occurred during ecdysis. The speed of metamorphosis appeared to be slowed down.

(*b*) *Adult locusts.* Similar feeds, both organic and inorganic, were given to adult locusts, and counts of up to 27,000 per minute at a distance of half an inch were obtained. With adults, the counts were much more uniform than with hoppers. Using a 'Devilbliss' No. 15 atomizer, adult *L. migratoria* were also sprayed with phosphorus-32 in a wetting agent and their subsequent counts recorded.

As in the case of hoppers, but to a slightly lesser degree, phosphorus-32 was rapidly absorbed by adults, both as an organic and an inorganic salt, and was retained for a period of up to five weeks. Treated adults could be recognized at a distance of ten inches for a fortnight. The Geiger counts for excreta, high

for the first twenty-four hours, fell rapidly to negligible proportions, the locusts losing 45 per cent of their radioactivity during that period.

Auto-photography of adult locusts given a forty-eight-hour radioactive feed showed a concentration in the metathoracic pair of legs and in the ovaries and testes. The wings appeared to hold no phosphorus-32, as distinct from those adults, reared from radioactive hoppers, the wings of which showed up clearly on the films. This difference would permit double marking with the same isotope of both hoppers and adults within a given population.

In view of the fact that locust hoppers cast their skins frequently, external marking is of no use. This being so, there is no adequate marker available other than a radioactive isotope, and for work where a β-ray is sufficient, phosphorus with a half-life of 14·3 days is the most suitable element. There is no difference in the absorption of it by a hopper whether it is given in an organic state in grass and maize made radioactive or as an inorganic salt in bran. The bran feed is the obvious method of choice in the field, and large numbers of first- and second-instar hoppers can thus be made radioactive at comparatively low cost. Much could be learnt about hopper movement and death-rate by this method, the only one at present available. Its use, however, would entail the expenditure of much time and labour by specialized staff using costly apparatus. An attempt was made to circumvent this by an approach to Messrs. Kodak, Ltd., with the object of obtaining a β-ray-sensitive 8 mm. film trace, suitably insulated and of known length, which could be laid in the track of advancing hoppers. With random sample counts taken over this for fixed periods, subsequent developing would show the passage of radioactive hoppers. Unfortunately, this method is so far inapplicable for β-rays, as there is no strip sufficiently sensitive for so short a traverse. For the present, therefore, orthodox methods, involving capturing hoppers with a net and scanning the bag with a Geiger counter, would have to be used, though direct scanning of hopper concentrations could possibly be undertaken at night. Future developments in the direction of using a portable scintillation counter, with material emitting a γ-ray, may simplify this.

Unless some automatic recording device can be found, it seems that for labelling adult locusts radioactive isotopes have no advantages over the well-tried colour paints, with which adults have been marked in the past for observing dispersal[2]. Untrained workers can see and record these, whereas radioactive locusts demand highly skilled technicians using special apparatus.

I wish to thank the following members of the University of Cape Town who gave me facilities: Prof. J. Day, Department of Zoology; Dr. A. M. Cormack, Department of Physics, for much technical advice; and Prof. E. Isaac and Dr. E. Schelpe, Department of Botany. I am also indebted to the Anti-Locust Research Centre for providing a grant for this work, and to the Nuffield Foundation for allowing me six months leave of absence. Full results have been deposited with the Anti-Locust Research Centre, British Museum (Natural History), London, S.W.7.

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Elution of Isoagglutinins adsorbed by Platelets

The existence of *A*, *B*, *O* and *AB* groups in thrombocytes, corresponding to these groups in red blood cells, has been reported[1,2]. The identity of the *A* and *B* antigens in platelets and red blood cells has been proved by: (1) platelet agglutination with antisera; (2) cross-adsorption of isoagglutinins with thrombocytes and erythrocytes; (3) inhibition of isoagglutinins with saliva from secretors; and (4) neutralization of antisera with *A*- and *B*-group specific substances. Similar results of agglutination of platelets were reported by Ruggieri and Bolognesi[3]. Adsorption of *A*- and *B*-isoagglutinins with platelets was reported by Moureau and André[4].

The present communication deals with studies on eluates of antisera adsorbed with large amounts of platelets. The method of elution used is based on that of Landsteiner and Miller[5]. Details of the preparation of platelet suspensions and sera have been described elsewhere[3].

To a platelet sediment prepared from 40–50 ml. of blood, 0·5 ml. of normal saline was added, and the tube shaken gently for 3–5 min. at about 6° C., to obtain a homogeneous concentrate of platelets. This suspension was added to 0·7 ml. of a high-titred antiserum in a siliconed tube and left for 15–20 hr. at 6° C., being occasionally shaken. After centrifugation at 2,000 r.p.m. for 10 min., the adsorbed serum was pipetted off, and the platelet sediment washed three times in normal saline to ensure removal of traces of serum.

The washed platelet sediment was resuspended in 0·4 ml. of normal saline and vigorously shaken by hand in a water-bath at 56° C. for 5 min. It was then centrifuged at 56° C. for 1 min. at 3,000 r.p.m. and the supernatant eluate was immediately removed. Special precautions were taken to ensure a constant temperature of 56° C. during elution.

Using the above technique, eluates of fifteen different *A*, *B* and *O* sera were prepared and examined for agglutinating capacity against erythrocytes and thrombocytes. Typical results of elution experiments are given in Table 1.

Table 1

Titre of serum before adsorption with platelets	Adsorption with platelets of blood group	Titre of serum after one adsorption with platelets	Titre of eluate against red blood cells
Anti *A* 1:128	*A*	1:2	1:16
Anti *B* 1:256	*B*	1:64	1:32
Anti *A* 1:64	*AB*	1:4	1:16
Anti *B* 1:32		1:2	1:16
Anti *A* 1:128	*O*	1:64	0

Eluates with a titre of 1:16 and higher also agglutinated platelet suspensions of the corresponding blood group.

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, May 9

LABORATORY ANIMALS BUREAU (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 10 a.m.—Symposium on "The Breeding of Laboratory Animals".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Prof. D. L. Linton: "The Nature and Significance of Tors".

Tuesday, May 10

WRIGHT-FLEMING INSTITUTE OF MICROBIOLOGY (at St. Mary's Hospital Medical School, London, W.2), at 5 p.m.—Dr. D. A. Long: "The Response of the Host to Bacterial Infection" (Almroth Wright Lecture).

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF NAVAL ARCHITECTS (joint meeting with the INSTITUTE OF MARINE ENGINEERS, at 85–88 The Minories, London, E.C.3), at 5.30 p.m.—Symposium on "Advanced Machinery Installations Designed for the Maximum Saving in Weight and Space".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. Herbert C. Brown (Purdue University): "A Proposed Quantitative Treatment of Aromatic Substitution".*

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Dr. Harriett Ephrussi-Taylor (Université de Paris): "Induced Transformations of Bacteria".* (Further lectures on May 11 and 13.)

Wednesday, May 11

UNIVERSITY OF LONDON (at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2), at 3 p.m.—Mrs. C. Cockburn: "Social Insurance and its Relation to the Relief of Distress". (Second of seven University Extension Lectures on "The Development and Pattern of the Social Services".)

PHYSICAL SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 4.30 p.m.—Annual General Meeting, followed by Prof. H. S. W. Massey, F.R.S.: "Progress and Problems of Physics To-day" (Presidential Address).

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. A. Rittmann (University of Cairo): "Mountain-building and Volcanism".

MEDICAL RESEARCH COUNCIL (at the National Institute for Medical Research, Mill Hill, London, N.W.7), at 5 p.m.—Dr. Emil L. Smith (University of Utah): "The Chemistry of Antibodies and Gamma Globulins".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Symposium on "Linear Programming". Papers by Dr. S. Vajda, Mr. E. M. L. Beale, Dr. G. Morton and Mrs. A. H. Land.

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. E. H. Walker, Mr. R. M. Eltringham and Mr. A. Puttick: "Evaporation Losses from Petrol Storage Tanks in the U.K.".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Papers on "Transistors and other Semi-Conductor Devices".

ROYAL INSTITUTION, LIBRARY CIRCLE (at 21 Albemarle Street, London, W.1), at 5.30 p.m.—Mr. Ralph Cory: "Library Reminiscences".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Annual General Meeting, followed by the Chairman's address—"Wartime Food Processing Problems in Retrospect".

Thursday, May 12

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Film illustrating some of the research activities of the Istituto Superiore di Sanità, Rome, with a brief introductory address by the Director-General—Prof. D. Marotta. Prof. E. B. Chain, F.R.S.: "Some Recent Advances in Carbohydrate Metabolism".

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Prof. Emil L. Smith (Utah): "Mode of Action of Proteolytic Enzymes". (Further lectures on May 16 and 19.)*

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. D. H. Little and Mr. A. Augustus Smith: "Some Steel Structural Frames Designed on Plastic Theory".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "Image Intensification in Radiology".

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Physics Department of Imperial College, Imperial Institute Road, London, S.W.7), at 5.40 p.m.—Mr. D. W. Robinson and Mr. R. S. Dadson: "A Redetermination of the Equal-loudness Relations for Pure Tones".

UNIVERSITY OF LONDON (at Wye College, Wye, near Ashford, Kent), at 8.15 p.m.—Prof. Fredrik Nilsson (Sweden): "Horticultural Research in Sweden with special reference to Berry Fruits".*

Friday, May 13

SOCIETY FOR ANALYTICAL CHEMISTRY, BIOLOGICAL METHODS GROUP (in the Lecture Hall of the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 2.30 p.m.—Meeting on "Biological and Microbiological Methods of Estimating Vitamin B_{12}".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. J. Manhajm and Dr. D. C. Sweeney: "Hydraulic Lock"; Mr. A. E. Bingham: "Liquid Springs: Progress in Design and Application".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. R. W. Douglas: "The No-Man's Land between Conductors and Insulators".

Saturday, May 14

BIOCHEMICAL SOCIETY (at the University, Reading), at 11 a.m.—Scientific Papers.

BRITISH INTERPLANETARY SOCIETY (in the York Hall of Caxton Hall, Caxton Street, Westminster, London, S.W.1), at 6 p.m.—Short Paper Evening.*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT, Grade B (graduate in mathematics, engineering or science, and with teaching or industrial experience), IN THE DEPARTMENT OF MATHEMATICS—The Registrar, College of Technology and Commerce, The Newarke, Leicester (May 12).

CHAIR OF PHYSICAL METALLURGY at the Imperial College of Science and Technology, London, S.W.7—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 13).

ASSISTANT LECTURER OR LECTURER IN THE DEPARTMENT OF PHARMACOLOGY AND THERAPEUTICS—The Registrar, The University, Liverpool (May 14).

LECTURER (with a degree in physics and suitable teaching experience) IN PHYSICS—The Principal, Acton Technical College, High Street, Acton, London, W.3 (May 14).

LECTURER (with a good honours degree and an interest in the history and philosophy of science) IN EDUCATION—The Registrar, The University, Sheffield (May 14).

LECTURER (with a good honours degree, and preferably with teaching and industrial experience) IN PHYSICS, and an ASSISTANT, Grade B, IN PHYSICS, at Bournemouth Municipal College of Technology and Commerce—The Chief Education Officer, Town Hall, Bournemouth (May 14).

LECTURER (with special qualifications in organic chemistry) IN CHEMISTRY—The Registrar, King's College, Newcastle-upon-Tyne (May 14).

RESEARCH FELLOWS and RESEARCH ASSISTANTS IN THE DAVY FARADAY RESEARCH LABORATORY of the Royal Institution, to work in the fields of X-ray crystallography and metal physics—Sir Lawrence Bragg, F.R.S., Royal Institution, 21 Albemarle Street, London, W.1 (May 14).

SENIOR PHYSICIST (with a thorough knowledge of classical and modern physics, and with research experience of Ph.D. standard) IN THE REGIONAL PHYSICS DEPARTMENT—The Secretary and Treasurer, Board of Management for Glasgow Western Hospitals, 10 Park Circus, Glasgow, C.3 (May 14).

LECTURER IN EDUCATION—The Principal, Borough Road College, Isleworth, Middx (May 16).

LECTURER IN MATHEMATICS at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (South Africa, May 16).

LECTURER OR ASSISTANT LECTURER (with experience of university teaching, and preferably with special qualifications in petrology) IN THE DEPARTMENT OF GEOLOGY—The Secretary and Registrar, The University, Southampton (May 16).

LECTURER (with special interests in the teaching of biology) IN GENERAL SCIENCE, at Didsbury Training College—The Chief Education Officer, (S3/L), P.O. Box 480, Education Offices, Manchester 3 (May 16).

ASSISTANT LECTURER IN PHYSICS, and a LECTURER IN MECHANICAL ENGINEERING at Manchester Municipal College of Technology (Faculty of Technology in the University of Manchester)—The Registrar, College of Technology, Manchester (May 23).

LECTURER (with a degree or recognized diploma in mining) IN THE DEPARTMENT OF MINING AND GEOLOGY—The Principal, Wigan and District Mining and Technical College, Wigan (May 23).

PROFESSOR OF APPLIED ELECTRICITY AND HEAD OF DEPARTMENT, and a PROFESSOR OF PHILOSOPHY AND HEAD OF DEPARTMENT—The Secretary and Registrar, University College of North Wales, Bangor (May 23).

ELECTRONICS ENGINEER or PHYSICIST (with recognized professional qualifications in electronics, and an interest in computing machines) IN THE COMPUTATIONAL LABORATORY, to work on problems of character recognition in connexion with mechanical translation—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (May 28).

ASSISTANT (science graduate) IN THE BACTERIOLOGY DEPARTMENT—The Medical Superintendent, Western Infirmary, Glasgow (May 29).

CHAIR OF MECHANICAL ENGINEERING—The Registrar, The University, Leeds 2 (May 30).

CHAIR OF ENGINEERING (Mechanical) at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, May 31).

HEAD OF THE DEPARTMENT OF GEOLOGY at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (May 31).

LECTURER IN PHYSICS—The Secretary of University Court, The University, Glasgow (May 31).

ANALYTICAL CHEMIST, Principal Research Officer or Senior Research Officer grade, with the Australian Atomic Energy Commission, to supervise an analytical service and develop new analytical methods in chemistry and radiochemistry—The Secretary, Australian Atomic

Energy Commission, 45 Beach Street, Coogee, N.S.W., Australia, or to A.A.E.C. Liaison Officer, Australia House, Strand, London, W.C.2 (June 1).

Assistant Lecturer in Inorganic and Physical Chemistry—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (June 4).

Coke Research Fellow (graduate of a British University) for research in the Department of Fuel Technology and Chemical Engineering—The Registrar, The University, Sheffield (June 12).

Analyst (with a first- or second-class honours degree with chemistry as the main subject, and preferably with a previous knowledge of the natural rubber industry) at the Rubber Research Institute of Malaya, Kuala Lumpur, to take charge of the analytical services in the Chemical Division, and to conduct research into new methods appropriate to raw materials and products of the natural rubber industry, and a Soils Chemist (with a first- or second-class honours degree and at least three postgraduate years experience) in the Soils Division, to undertake work on soil fertility problems with particular reference to rubber cultivation—The Secretary, London Advisory Committee for Rubber Research, Imperial Institute, London, S.W.7 (June 15).

Assistant Lecturer in Physics at the University College of Khartoum—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1.

Assistant Meteorologist (with H.S.C. or equivalent in mathematics and physics, and preferably with experience in forecasting) with the Nigerian Federal Government—The Crown Agents, 4 Millbank, London, S.W.1, quoting M3B/34743/TA.

Biochemist, Scientific Officer grade (preferably with some mechanical aptitude), to study the composition and purification of large-scale preparations of leaf protein—The Secretary, Rothamsted Experimental Station, Harpenden, Herts, quoting "167".

Lecturer or Assistant Lecturer in Physics—The Registrar, The University, Nottingham.

Livestock Improvement Officer (with a degree in agriculture and general farming experience, and a bias towards livestock management), in Uganda, to manage one of two experimental farms at which problems of animal breeding, feeding and management are under investigation—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting BCD.67/9/06.

Principal Scientific Officer or Senior Scientific Officer (with a first- or second-class honours degree in chemistry and with experience in the operation of chemical plant in the explosives field), to take charge of explosive research and development work on pilot plant scale and to direct pilot plant operation—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 637/WGE/2.

Reader and Senior Lecturers or Lecturers in Chemistry—The Dean, College of Arts and Science, Baghdad, Iraq.

Scientific Officer (preferably with previous research experience) in the Chemistry Department, for work on the physical chemistry of soil—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

Scientific Officer (with a first- or second-class honours degree or equivalent in electrical engineering or physics, and with a bias towards electronics) at an R.A.F. Experimental Establishment in Norfolk, for the development and adaptation of radio equipment pulse techniques, including aerials, power supplies and displays—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.163/5A.

Senior Lecturer in Agriculture—The Registrar, Wye College (University of London), Wye, near Ashford, Kent.

Senior Lecturer in the Department of Mathematics at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

Senior Scientific Officer or Scientific Officer (with at least a first- or second-class honours degree in physics or engineering, and with research experience in some problems involving a theoretical approach to engineering, and a reasonable knowledge of workshop practice), to carry out research on fundamental problems connected with the design of ultra-high speed rotating systems—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 522/WGE/34.

Senior Scientific Officer or Scientific Officer (with at least a second-class honours degree in physics or engineering, and preferably with some postgraduate experience in heat transfer), for experimental research work in the field of reactor cooling—The Establishments Officer, United Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 2/103/296.

Senior Scientific Officer (with at least a first- or second-class honours degree in mathematics or physics, and with a few years appropriate experience), for mathematical work associated with the design and development of radar and electronic devices—Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 596/WGE/2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 931, Vol. 247 (17 February 1955): On the Assessment of Optical Images. By P. B. Fellgett and E. H. Linfoot. Pp. 369–407. 12*s.* 6*d.* Series B: Biological Sciences. No. 656, Vol. 238 (10 February 1955): The Flight Muscles of Insects—Their Anatomy and Histology; with some Observations on the Structure of Striated Muscle in General. By O. W. Tiegs. The Path of the Slow Contractile Wave in Anthropod Muscle Fibre. By E. Matthaei and O. W. Tiegs. Pp. 221–359+plates 17–37. 80*s.* No. 657, Vol. 238 (10 February 1955): The Effect of Water and of Isotonic Saline Administration on the Renal Plasma and Glomerular Filtrate Flows in the Dog, with Incidental Observations of the Effects on these Flows of Compression of the Carotid and Renal Arteries. By R. V. Sellwood and E. B. Verney. Pp. 361–396. 12*s.* (London: Royal Society, 1955.) [212

National Coal Board. Report of the Advisory Committee on Organisation. Pp. iii+105. (London: National Coal Board, 1955.) 2*s.* 6*d.* [288

London School of Hygiene and Tropical Medicine, incorporating the Ross Institute (University of London). Report of the 29th Meeting of the Ross Institute Industrial Advisory Committee. Pp. 26. (London: Ross Institute of Tropical Hygiene, 1955.) [23

Association of Universities of the British Commonwealth. Report of the Executive Council together with the accounts of the Association, for the year 1st August 1953 to 31st July 1954. Pp. 22. (London: Association of Universities of the British Commonwealth, 1955.) [23

London School of Hygiene and Tropical Medicine, incorporating the Ross Institute (University of London). Report on the work of the School for the year 1953–1954. Pp. 136. (London: London School of Hygiene and Tropical Medicine, 1955.) [23

University of London. University College—Annual Report, 1953–1954. Pp. 97. (London: University College, 1955.) [23

International Tin Research Council. Annual Report, 1954. Pp. 28 (Publication 233). (Greenford, Mddx.: Tin Research Institute, 1955.) [23

Scottish Home Department. Marine Research, 1955. No. 1: The Plankton of the Waters Approaching the British Isles in 1953. By Dr. J. H. Fraser. Pp. 12. 2*s.* 6*d.* net. Freshwater and Salmon Fisheries Research. No. 7: Sixth Annual Report of the Supervisory Committee for Brown Trout Research, 1953–1954. Pp. 12. 2*s.* net. (Edinburgh: H.M. Stationery Office, 1955.) [23

Other Countries

U.S. Department of Commerce: National Bureau of Standards Handbook 57: Photographic Dosimetry of X- and Gamma Rays. By Margarete Ehrlich. Pp. iv+28. (Washington, D.C.: Government Printing Office, 1954.) 15 cents. [23

Lloydia: a Quarterly Journal of Biological Science. Vol. 17, No. 1: Flora of Dominica, B.W.I. Part 1. By W. H. Hodge. Pp. 90. (Columbus, Ohio: Lloyd Library and Museum, 1954.) [23

Smithsonian Miscellaneous Collections. Vol. 123, No. 6: A New Pictographic Autobiography of Sitting Bull. By Alexis A. Praus. (Publication 4180.) Pp. ii+4+7 plates. (Washington, D.C.: Smithsonian Institution, 1955.) [23

United States National Museum—Smithsonian Institution. Annual Report for the year ended June 30, 1954. Pp. ix+100. (Washington, D.C.: Smithsonian Institution, 1954.) [23

New Zealand. National Art Gallery and Dominion Museum. Report of the Board of Trustees for the year ended 31 March 1954. Pp. 19. (Wellington: New Zealand Dominion Museum, 1954.) [23

Smithsonian Institution: Bureau of American Ethnology. Bulletin 157: Anthropological Papers—Numbers 43–48. Pp. iii+415+76 plates. (Washington, D.C.: Government Printing Office, 1955.) 2.75 dollars. [23

Materiały z Konferencji fizyków w Spale. Pp. 366. (Warszawa: Panstwowe Wydawnictwo Naukowe, 1954.) Cena zł. 31.20. [23

Astronautica Acta. (Official journal of the International Astronautical Federation.) Vol. 1, Fasc. 1. Pp. 60. (Published quarterly. Yearly subscription rates: 216 Austrian schillings; 36 D. marks; 8.60 dollars; 37.20 Swiss francs; 62*s.*) (Wien: Springer Verlag; London: L. H. Maxwell and Co., Ltd., 1955.) [23

Smithsonian Miscellaneous Collections. Vol. 126, No. 3: A Revision of Some Glandulinе Nodosariidae (Foraminifera). By Alfred R. Loeblich, Jr., and Helen Tappan. (Publication 4189.) Pp. ii+9+1 plate. (Washington, D.C.: Smithsonian Institution, 1955.) [23

United States Naval Observatory. Circular No. 55 (January 10, 1955): Positions, Areas, and Counts of Sunspots, September–October, 1954. By Winifred Sawtell Cameron. Pp. 4. (Washington, D.C.: United States Naval Observatory, 1955.) [23

Institut des Parcs Nationaux du Congo Belge. Exploration du Parc National Albert. Monographie Éthnologique de l'Hippopotame (*Hippopotamus amphibius* Linné). Par René Verheyen. Pp. 91. (Bruxelles: Institut des Parcs Nationaux du Congo Belge, 1954.) [23

Reports and Proceedings of the World Congress of Doctors for the Study of Present-day Living Conditions—Vienna, 23–25 May, 1953. Pp. xvi+384. (Vienna: Congrès Mondial des Médécins; London: Caversham Centre, 25, Caversham Road, N.W.3.) 10*s.* 6*d.* [23

Inter-American Tropical Tuna Commission. Annual Report for the year 1953. Pp. 87. (La Jolla, Calif.: Inter-American Tropical Tuna Commission, 1954.) [23

Chicago Natural History Museum. Fieldiana—Geology. Vol. 10, No. 20 (December 27, 1954): Notes on an Eocene Crab, *Harpactocarcinus mississippiensis* Rathbun. By Eugene S. Richardson, Jr. Pp. 219–224. 25 cents. Fieldiana—Zoology. Vol. 34, No. 29 (December 23, 1954): Some Mites of Yemen, collected by the Medical Mission of the United States, Naval Medical Research Unit No. 3. By Charles D. Radford. Pp. 295–314. 45 cents. Vol. 34, No. 29 (December 23, 1954): A New Larval Mite from Eritrea (Acarina: Trombiculidae). By Charles D. Radford. Pp. 315–318. 10 cents. Vol. 34, No. 30 (December 23, 1954): The Annellated Corak Snake, *Micurus annellatus* Peters. By Karl P. Schmidt. Pp. 319–326. 10 cents. Fieldiana—Anthropology. Vol. 44, No. 1 (December 15, 1954): Proto-Lima: a Middle Period Culture of Peru. By A. L. Krober. Appendix: Cloths. By Dwight T. Wallace. Pp. 158. 4 dollars. (Chicago: Chicago Natural History Museum, 1954.) [23

Department of the Army: Corps of Engineers. Beach Erosion Board: Office of the Chief of Engineers. Technical Memorandum No. 52: Laboratory Study of Effect of Tidal Action on Wave-Formed Beach Profiles. By George M. Watts and Robert F. Dearduff. Pp. iii+21. Technical Memorandum No. 62: Restudy of Test-Shore Nourishment by Offshore Deposition of Sand, Long Branch, New Jersey. By Robert L. Harris. Pp. iv+18. Technical Memorandum No. 69: Wave Forces on Piles: a Diffraction Theory. By R. C. McCamy and R. A. Fuchs. Pp. iii+17. Technical Memorandum No. 70: The Effect of Fetch Width on Wave Generation. By Thorndike Saville, Jr. Pp. ii+9. (Washington, D.C.: Beach Erosion Board, Office of the Chief of Engineers, 1954.) [23